

**PRELIMINARY RESULTS OF A RECREATIONAL USE ATTAINABILITY ANALYSIS  
OF THE BRAZOS RIVER ABOVE POSSUM KINGDOM (1208), NAVASOTA RIVER  
ABOVE LAKE MEXIA (1210A), EAST YEGUA CREEK (1212B), AND THE  
LOWER CIBOLO CREEK (1902)**

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## Summary

Three hundred and thirty-five miles of streams were evaluated with 236 surveys in this RUAA to evaluate whether the existing and/or attainable recreational uses of these streams might be different than the presumed or designated recreational uses. Important data collected in this RUAA included general stream characteristics, observations and evidence of recreational use, surrounding conditions that promote and impede recreation, channel obstructions, and interviews. One hundred and forty nine RUAA surveys on the Brazos River, 69 on Lower Cibolo Creek, 15 on East Yegua Creek, and 5 on the Navasota River were completed.

Two publicly owned recreation areas were found on East Yegua Creek at survey points 1212B.25 and 1212B.26. One publicly owned recreation area was found on the Lower Cibolo Creek at survey point 1902.1 and 1902.2. No publically owned recreation areas were found on the Brazos River, or the Navasota River. Both the Brazos River and the Lower Cibolo Creek, however, had privately owned recreation areas that were easily accessible and widely used by local residents.

Shrubs were the dominant riparian zone recorded for all streams, 48%, followed by forest (33%), denuded/eroded bank (6%), pasture (5%), and herbaceous marsh (4%). Eighty four percent of the Brazos River riparian zone is shrub and forest combined followed by Lower Cibolo Creek (82%), Navasota River (75%), and East Yegua Creek (51%).

The Brazos River had the largest average width (47.4 m), thalweg (0.7 m), and flow (331.5 ft/s). The Lower Cibolo Creek had an average width of 12.8 m, thalweg of 0.8 m, and flow of 32.8 ft/s. The Navasota River had an average width of 3.8 m, thalweg of 0.5 m, and flow of 2.3 ft/s. East Yegua Creek had an average width of 6.7 m, thalweg of 0.4 m, and flow of 37.8 ft/s.

The RUAA summary analysis for each stream showed that primary contact frequently occurs on the Brazos River and the Lower Cibolo Creek and seldom occurs on East Yegua Creek or the Navasota River. Secondary contact recreation 1 activities frequently occur on the Brazos River and the Lower Cibolo Creek and seldom occur on the Navasota River. The Brazos River,

Navasota River, and the Lower Cibolo Creek had average thalwegs greater or equal to 0.5 m. All four streams had substantial pools. General public access was moderate on the Brazos River and the Lower Cibolo Creek and very limited for East Yegua Creek and the Navasota River.

Seven people on the Brazos River and 14 on the Lower Cibolo Creek were observed carrying out primary contact recreation activities. These activities included swimming, tubing, diving, and wading-children. Twelve people on the Brazos River and 40 people on the Lower Cibolo Creek were observed carrying out secondary contact recreation activities. No primary, secondary, or noncontact activities were observed on the Navasota River or East Yegua Creek.

Sixteen IHUs relating to primary contact recorded for the Lower Cibolo Creek included rope swings (8), zip line (1), inner tube (1), and 6 docks or platforms. Two docks or platforms were the only IHU relating to primary contact that were recorded for the Brazos River. Six IHUs relating to secondary contact 1 were recorded for the Lower Cibolo Creek and 11 for the Brazos River. These included children's toys, remnants of kid's play, canoe/kayaks, boats, and drag marks from a boat. IHUs related to secondary contact 1 and possible fish consumption were recorded for the Brazos River (22), Lower Cibolo Creek (59), and East Yegua Creek (4).

Eight surroundings conditions that promote primary and secondary I contact were recorded for the Lower Cibolo Creek followed by 7 for the Brazos River. These included a rope swing and chairs on the bank, boat docks or rafts, beaches, a cliff for jumping in the river, boating access, a trot line, and a bench with fishing rod holders. No access was recorded as impeding recreation on the Brazos River (169), Navasota River (1), East Yegua Creek (11), and the Lower Cibolo Creek (40). Warning signs were also recorded as impeding recreation on the Brazos River (125), Navasota River (5), East Yegua Creek (10), and the Lower Cibolo Creek (58). Log jams, low bridges, and bridge pillars were the most frequent channel obstructions recorded.

The majority of people that were interviewed along the Brazos River stated using the river for recreation. Wading of children and swimming were the most frequently reported primary contact activities that involved the person that was interviewed and her/his family. Frequent secondary contact activities were fishing for consumption and catch and release. Hunting was the most frequently reported noncontact activity. Interestingly, people reported witnessing camping, canoeing, and boating; and hearing of tubing and 4-wheeling in higher frequencies than

when the activities involved themselves and their families. The reasons most frequently argued for not recreating in the river were having other personal interests or that the water level was too low for recreation.

Reports of personal and family recreational activities by interviewees in the Brazos River date back to the 1940's. Wading of children and swimming have been recurrent recreational activities since the 1950's. Among secondary contact recreational activities, fishing, and boating have been prevailing activities since the 1950's.

Nearly half of the people interviewed stated that recreational activities in the Brazos River have changed through time. Water level, water quality, and physical characteristics of the river bed were the most frequently stated reasons for such changes. Nevertheless people continue recreating in the Brazos and the frequency of some of the current personal and family activities reported was relatively higher than the frequency of the same activities in the past.

Only one of the people interviewed along the Navasota River stated using the river for recreation. Two landowners have witnessed picnics, arrow hunting, and fishing in this segment of the river. The two landowners that do not use the river argued that the water level is too low for recreation.

Over half of the people that were interviewed along East Yegua Creek stated using the creek for recreation. Fishing for consumption and catch and release were the most frequently reported secondary contact activities that involved the person that was interviewed and her/his family. Hunting was the most frequently reported noncontact activity. Half of the people have witnessed recreation in the creek, and the frequency of occurrence of these activities is roughly the same as the activities that involve the interviewees and their families, except for one report of witnessing canoeing and one report witnessing kayaking. People that stated that they did not recreate in the creek argued that the water level is too low for recreation.

Reports of personal and family recreational activities by interviewees in East Yegua Creek date back to the 1980's, although the majority of the interviewees stated recreating in the last ten years. Nearly half of the people interviewed stated that recreational activities in the creek have changed through time due to decreased water levels. Even though no current primary contact activities were reported, one person reported swimming and tubing as recreational activities that

characterized the creek in the past. The frequency of fishing for consumption has also decreased relative to the past.

The majority of people that were interviewed along the Lower Cibolo Creek stated using the creek for recreation. Swimming was the most frequently reported primary contact activity that involved the person that was interviewed and her/his family. Frequent secondary contact activities were fishing for consumption and catch and release. Hunting was the most frequently reported noncontact activity. People reported witnessing boating, canoeing, and fishing; and hearing of swimming, canoeing and hunting in higher frequencies than when the activities involved themselves and their families. The reasons most frequently argued for not recreating in the creek were having other personal interests or that the water quality was too poor for recreation.

Reports of personal and family recreational activities by interviewees in the Lower Cibolo Creek date back to the 1950's. Swimming and fishing appear to be prevailing activities since then. Over half of the people interviewed stated that recreational activities in the Lower Cibolo have changed through time. Poor water quality was the most frequently stated reason for such changes. Changes in water quality and water level may have influenced the current decrease in swimming and increase of noncontact recreational activities.

## **Introduction**

Section 101(a)(2) of the Federal Water Pollution Control Amendments of 1972 or the Clean Water Act (the Act) states it is the national goal, wherever attainable, to provide for the protection and propagation of fish, shellfish, and wildlife and provide for recreation in and on the waters of the United States. Under section 131.10(j) of the Water Quality Standards Regulation of the United States Environmental Protection Agency (EPA), States are required to conduct a use attainability analysis (UAA) whenever the State designates uses of water bodies that do not include the uses specified in section 101(a)(2) of the Act, removes one of these designated uses, or adopts subcategories of these uses that require less stringent criteria.

A UAA (or RUAA) is a structured scientific assessment of the factors affecting the attainment of a use on a water body. The overall purpose of a RUAA is to make sure streams have the correct recreational use classification following the guidelines established in the Act. The ultimate goal is that the new designated use classification is more accurate.

RUAAs may include physical, chemical, and biological evaluations to determine what factors impair attainment of designated uses and provide information to determine what uses are appropriate and feasible for the water body in question. Important factors in such analyses can include naturally occurring pollutant concentrations, anthropogenic sources of pollution, water depth, hydrological modifications, and natural physical characteristics of streams that could impair the use. In addition, LUAAs typically assess the current uses (recreation and otherwise) of the water bodies under evaluation.

States use the information collected in a RUAA to demonstrate to the public and/or EPA that:

- A. the existing or presumed use in section 101(a)(2) is appropriate, or
- B. attainment of the existing or presumed use in section 101(a)(2) is not feasible because:
  - 1. naturally occurring pollutant concentrations prevent the attainment of the use;

2. natural, ephemeral, intermittent, or low- flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met;
3. human-caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place;
4. hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use;
5. physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to [chemical] water quality, preclude attainment of aquatic life protection uses; or
6. controls more stringent than those required by sections 301(b)(1)(A) and (B) and 306 of the Act would result in substantial and widespread economic and social impact.

On June 7 through August 29, 2010, a team from Texas AgriLife Research, Texas A&M University System, carried out RUAAAs for the Brazos River Above Possum Kingdom (1208), East Yegua Creek (1212B), Lower Cibolo Creek (1902), and Navasota River Above Lake Mexia (1210A). Following the methodology in TCEQ's 2009 Recreational Use Attainability Analysis Procedures, team members talked with landowners on these streams, interviewed recreational users, and collected data. The Water Quality Standards Group within the TCEQ will use this information to potentially classify or reclassify streams in the categories of primary contact recreation, secondary contact recreation 1, secondary contact recreation 2, and noncontact recreation.



## **Historical Information Review of Classified Streams**

### **Classified Stream Segment 1208 (Brazos River Above Possum Kingdom):**

The Brazos River derives its name from *El Rio de los Brazos de Dios* or *The River of the Arms of God* given by early Spanish explorers (Huser, 2000). At 1,050 miles long and with a drainage area of 44,620 square miles, the Brazos is considered the longest river in Texas (Hendrickson, 1981).

The Brazos River Above Possum Kingdom (1208) is located within the USGS Hydrologic Unit 120500: Texas-Gulf Region > Brazos Headwaters Subregion. This hydrologic unit, or watershed, encompasses approximately 14,600 square miles (Seaber et al. 1994) including several counties in the Low Rolling Plains and North Central Texas Divisions in Texas (Appendix 1).

### **Climate**

The upper portion of the Brazos River (1208), from its origin upstream to sampling site 1208.65 is located within the Low Rolling Plains Climate Division (i.e. division No. 2, NOAA 2005). The summer season is characterized by persistent hot weather from May to September, with monthly maximum temperatures over 80 °F (Fig. 1) and the highest average rainfall occurring between May and June (i.e. over 3.0 inches, Fig. 2). The cool season extends from November to March with monthly minimum temperatures under 40 °F (Fig. 1) and average rainfall less than 1.6 inches during these months (Fig. 2).

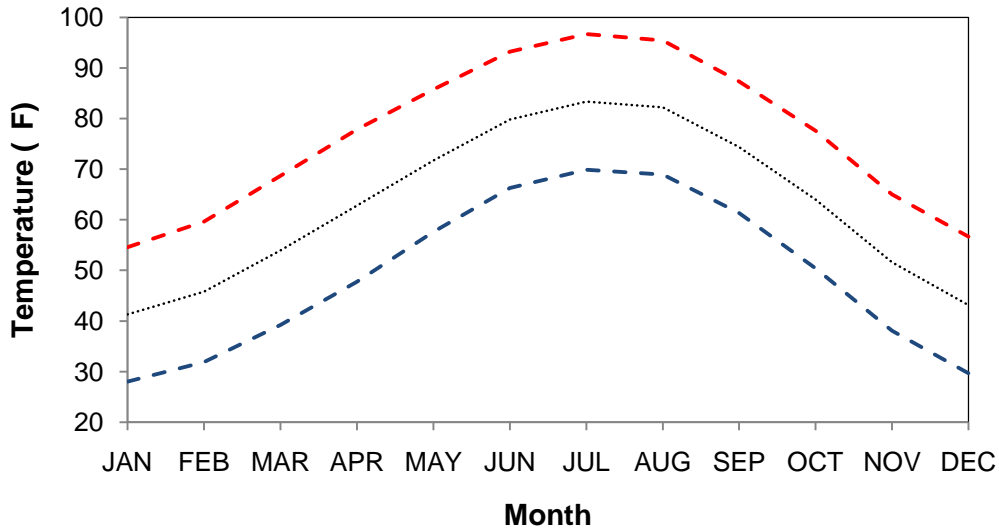


Figure 1. Monthly average normal minimum (blue dashed line), mean (dotted line) and maximum temperatures (red dashed line) for Aspermont City, Stonewall County, Texas (Jan 1970 – Oct 2010); Data from NOAA 2011).

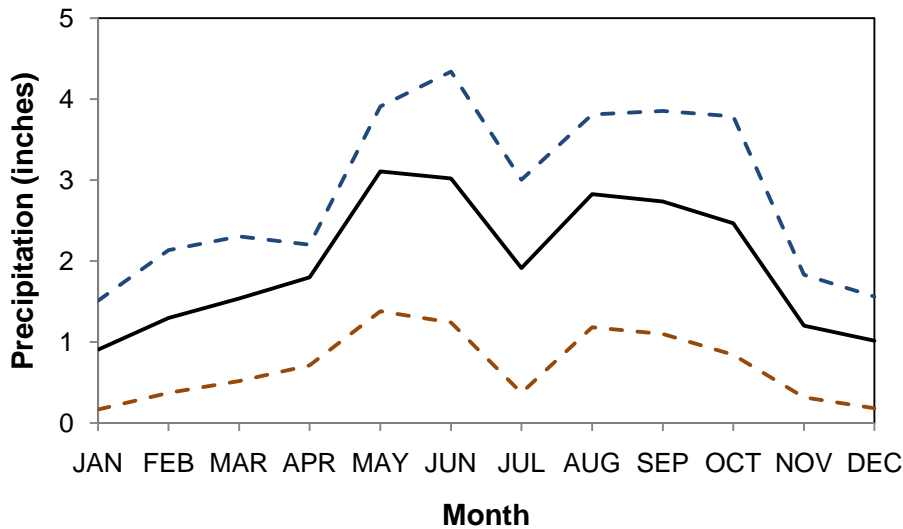


Figure 2. Monthly average 25<sup>th</sup>-percentile (lower dashed line), mean (solid line), and 75<sup>th</sup>-percentile (upper dashed line) precipitation for Aspermont City, Stonewall County, Texas (1970 – 2010); Data from NOAA 2011).

Drought indices estimate moisture conditions over different time scales (NOAA 2009a). Two drought indices for the Low Rolling Plains Climate Division have been included as a general reference to historical short-term “weather spells” and long-term conditions for the area (Figs. 3

& 4, NOAA 2009b). Palmer Z Index (PZI) measures short-term drought on a monthly scale. Palmer Hydrological Drought Index (PHDI) estimates long-term conditions by taking into account the hydrological effects of previous and current surface and groundwater levels. As a result, PHDI values respond more slowly to changing weather conditions (NOAA 2009a, Weber 1998). Both indices center on zero as “normal” conditions. The relative wetness (positive values) or dryness (negative values) of a monthly time period is proportional to the distance away from zero (NOAA 2007).

Historically (1970—2010), monthly short-term moisture conditions have regularly fluctuated between wet and dry spells on average every 23 months (2.5 months for wet spells and 2.7 months for dry spells) with the longest short-term spells lasting 12 (dry spells) to 15 (wet spells) months (Fig. 3). The longest short-term wet spells occurred between June 1991—August 1992 and November 1992—July 1993 while the longest short-term dry spells occurred between August 1970—July 1971, October 1973—July 1974, and October 1995—July 1996.

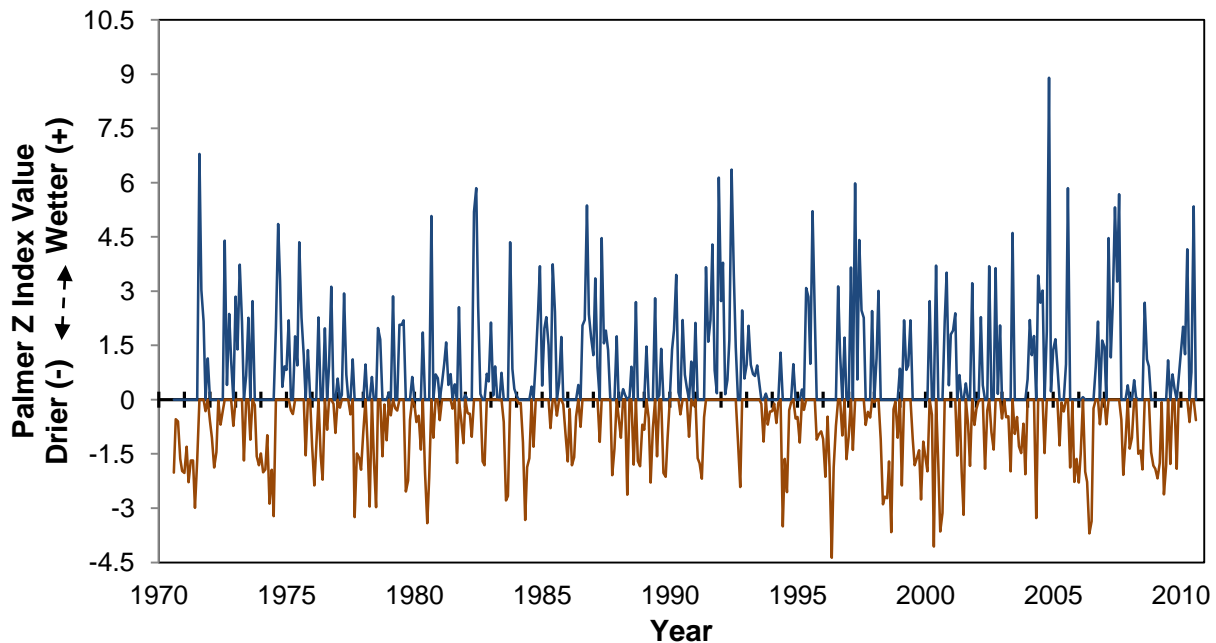


Figure 3. Short-term moisture departures from normal (Palmer Z Index) for the Rolling Plains Climatic Division (August 1970 – August 2010; Data from NOAA 2009b).

Long-term moisture conditions showed more extreme departures from normal conditions (Fig. 4). Although there were equal numbers of long-term wet and dry periods (i.e. 27), wet periods

tended to last longer. The average duration of long-term wet periods was 10.6 months and ranged from 1 to 36 months. The longest long-term wet period (36 months) occurred between June 1991—May 1994. Long-term dry periods averaged 6.9 months and ranged from 1 to 17 months. The longest long-term dry period (17 months) occurred between August 1999—March 2001.

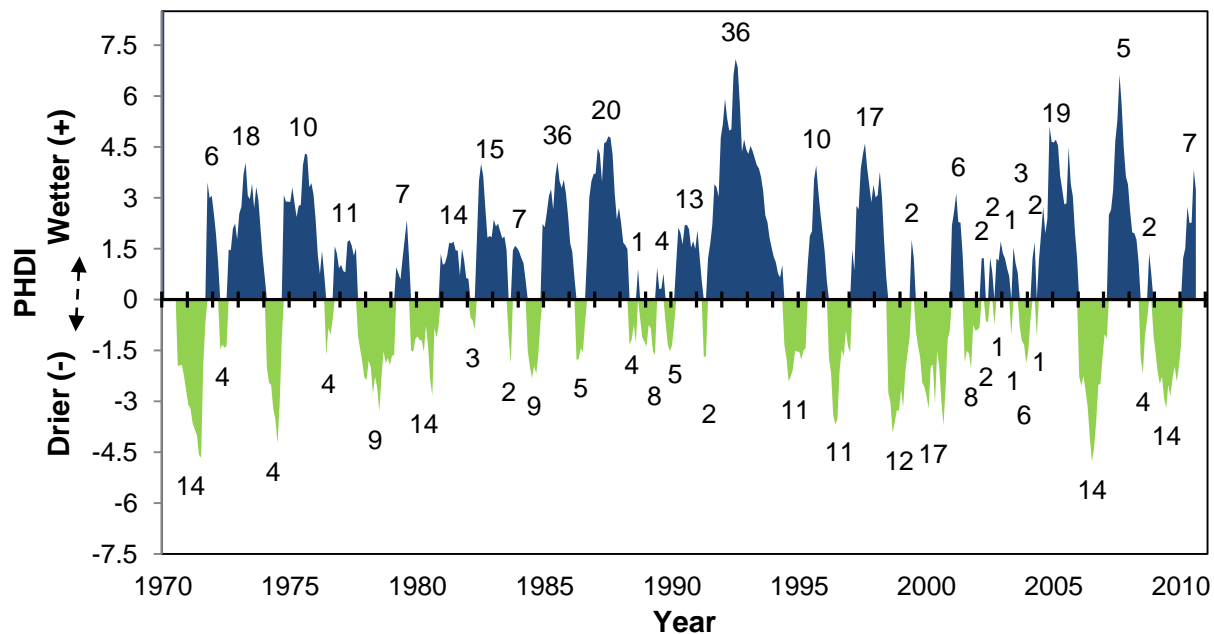


Figure 4. Long-term moisture conditions (Palmer Hydrological Drought Index Values, PHDI) and duration in months (numbers) for the Rolling Plains Climatic Division (August 1970 – August 2010; Data from NOAA 2009b).

The middle and lower portion of the Brazos River (1208), from sampling site 1208.66 to sampling point 1208.111, is located within the North Central Texas Climatic Division (i.e. division No. 3, NOAA 2005). The climate of the region is classified as subtropical, subhumid. Summers are usually hot and humid, while winters are often mild and dry. The summer season is characterized by persistent hot weather from May to September, with monthly maximum temperatures over 80 °F (Fig. 5). The highest average rainfall occurs between May and June (i.e. over 3.5 inches), followed by another rainy season in the fall between September and October (i.e. 3.6 inches; Fig. 6). The cool season extends from November to February with monthly

minimum temperatures under 40 °F (Fig. 5) and average rainfall is less than 2 inches during these months (Fig. 6).

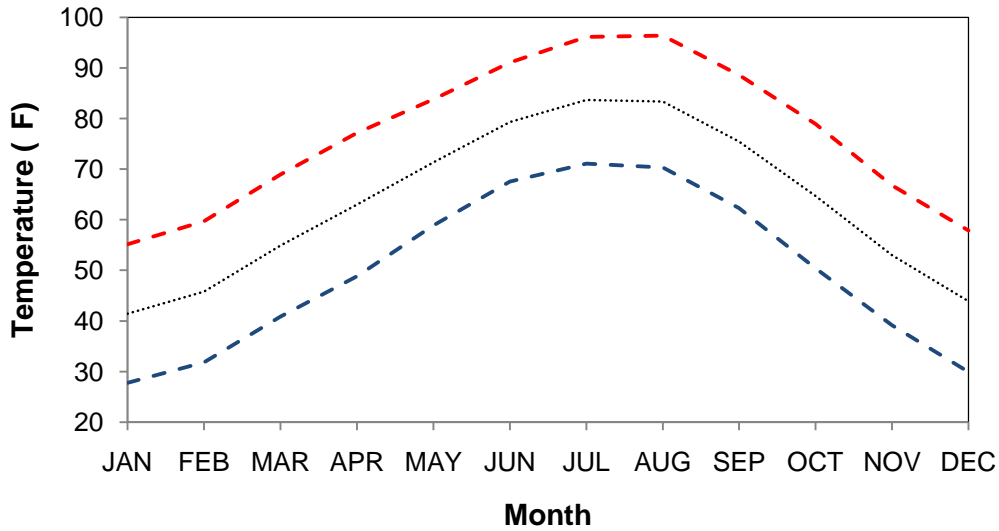


Figure 5. Monthly average normal minimum (blue dashed line), mean (dotted line) and maximum temperatures (red dashed line) for Graham City, Young County, Texas (Jan 1970 – Oct 2010); Data from NOAA 2011).

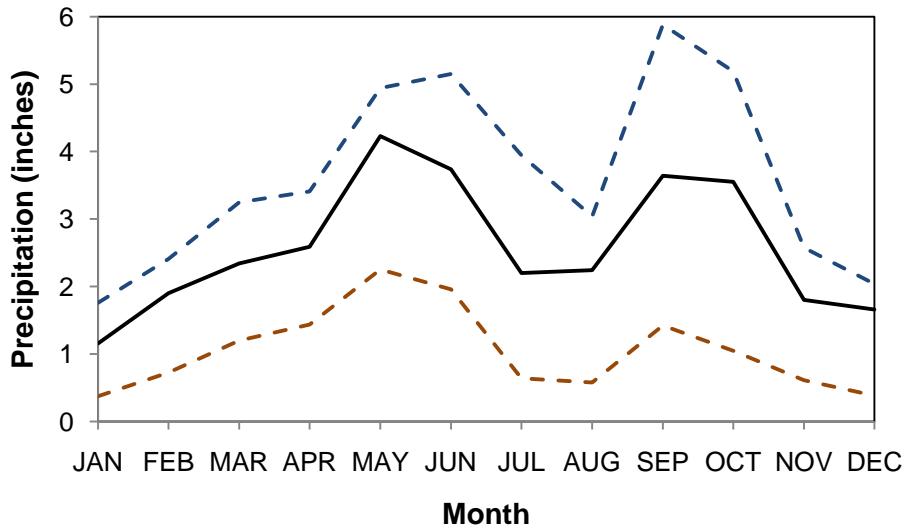


Figure 6. Monthly average 25<sup>th</sup>-percentile (lower dashed line), mean (solid line), and 75<sup>th</sup>-percentile (upper dashed line) precipitation for Graham City, Young County, Texas (1970 – 2010); Data from NOAA 2011).

Historically (1970—2010), monthly short-term moisture conditions have regularly fluctuated between wet and dry spells on average every 23 months for wet spells and dry spells with the longest short-term spells lasting 10 (wet spells) to 11 (dry spells) months (Fig. 7). The longest short-term wet spells occurred between May 1986—Feb 1987 and June 1991—March 1992 while the longest short-term dry spells occurred between October 1995—November 1996 and July 1999—May 2000.

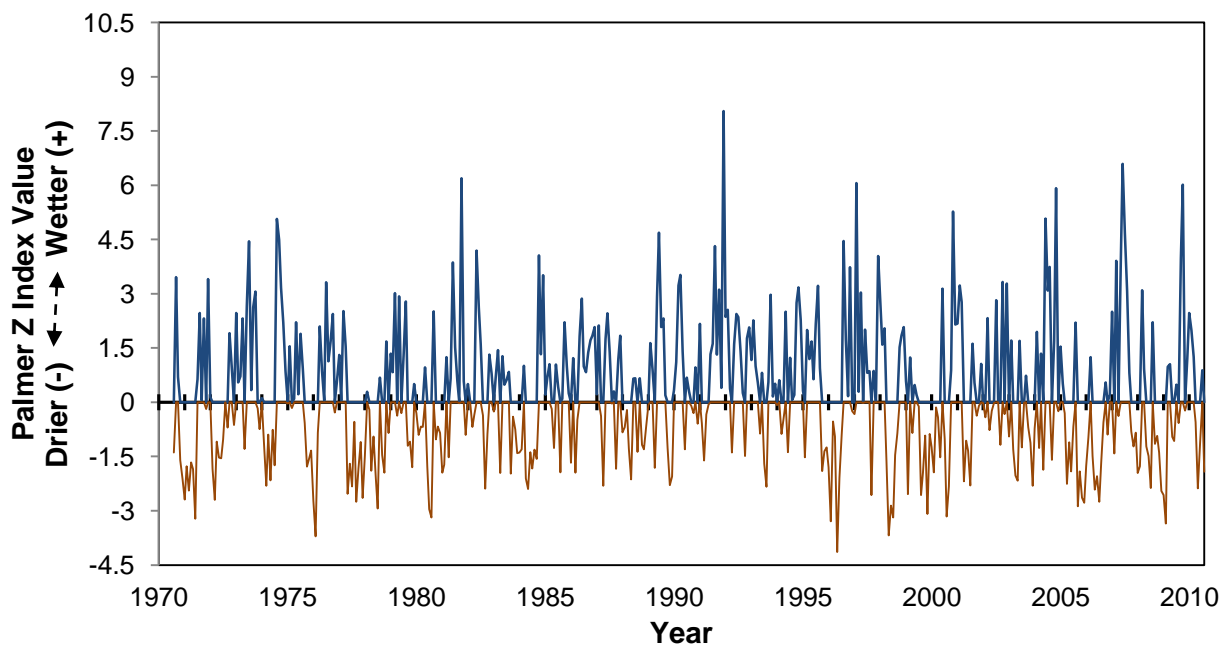


Figure 7. Short-term moisture departures from normal (Palmer Z Index) for the Central Texas Climatic Division (August 1970 – August 2010; Data from NOAA 2009c).

Long-term moisture conditions showed more extreme departures from normal conditions (Fig. 8). Although there were equal numbers of long-term wet and dry periods (i.e. 16), wet periods tended to last longer. The average duration of long-term wet periods was 17 months and ranged from 1 to 83 months. The longest long-term wet period (83 months) occurred between June 1991—May 1994. Long-term dry periods averaged 10.6 months and ranged from 1 to 20

months. The longest long-term dry periods (20 months) occurred between July 1977—February 1979 and September 2005—April 2007.

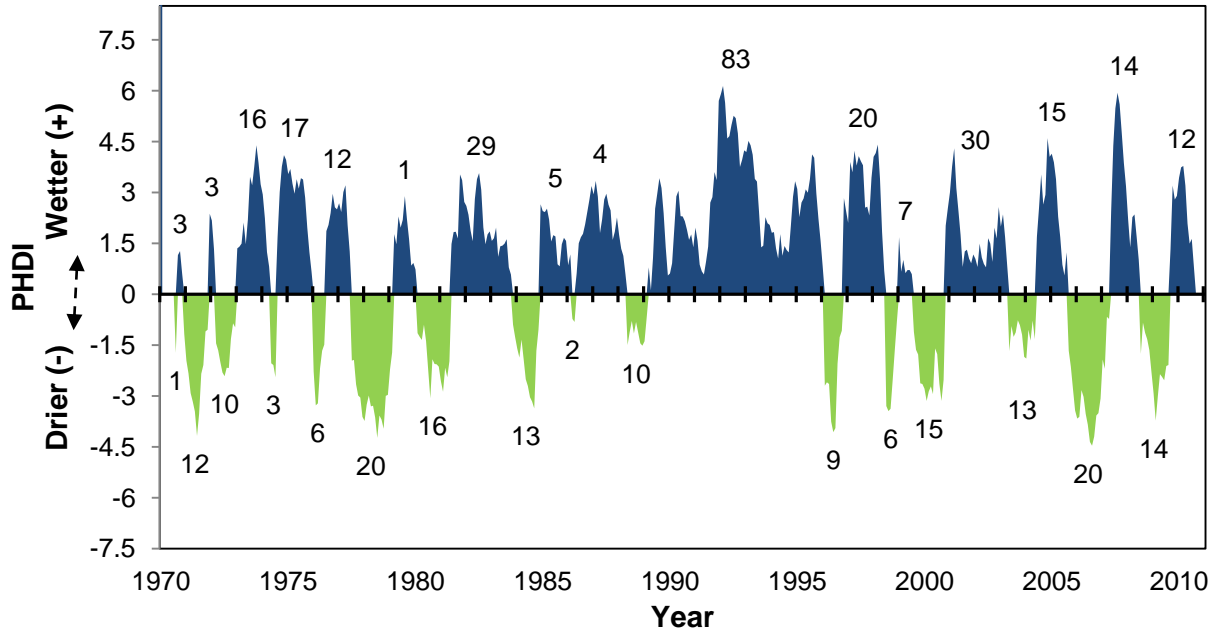


Figure 8. Long-term moisture conditions (Palmer Hydrological Drought Index Values, PHDI) and duration in months (numbers) for the Central Texas Climatic Division (August 1970 – August 2010; Data from NOAA 2009c).

### Local Population

The Brazos River (1208) flows through five counties. Originating in Stonewall, the Brazos River (1208) runs through Knox, Baylor, Throckmorton, and Young County. General descriptions of local populations by county are presented below and are based on data from the United States Census Bureau. Otherwise stated, population estimates and statistics represent averages between January 2005 and December 2009 (Census 2011).

## Stonewall County

This county covers 918.67 square miles and had an estimated population of 1,354 (1.8 persons/mi<sup>2</sup>) in 2009. The population has decreased by 20% since 2000 and by 43.5% since 1970 (Fig. 9). Infants and young accounted for a quarter of the total population in 2009 (i.e. 24.9% were under 18 years old, and 8.2% were children under 5 years old). The totality of the population is considered rural. Agriculture, forestry, fishing, hunting, and mining accounted for 26% of employment opportunities in Stonewall County, between 2005 and 2009. These economical activities represented the second largest source of employment in the county after educational services, health care, and social assistance occupations.

The Brazos River extends over approximately 9.88 miles in Stonewall County, along agricultural fields. The largest populated area is the town of Aspermont with an estimated population of 645 in 2009. Aspermont is located 15 mi away from the Brazos River, measured from the beginning of the segment.

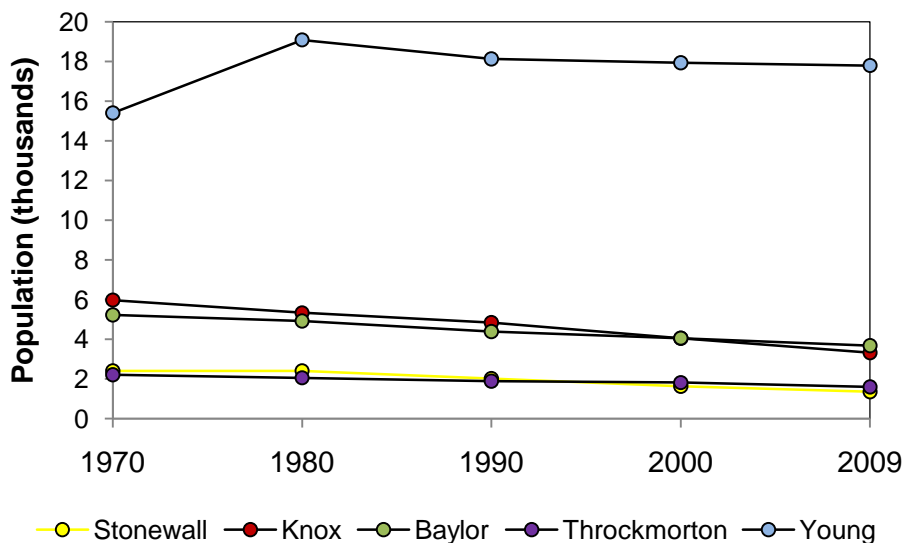


Figure 9. Decennial U.S. Census population values for counties along the Brazos River (1208), Texas. (Data from Census 2011).



## **Knox County**

This county covers 849.0 square miles and had an estimated population of 3,322 (5.0 persons/mi<sup>2</sup>) in 2009. The population has decreased by 22% since 2000 and by 44.3% since 1970 (Fig. 9). Infants and young accounted for nearly a quarter of the total population in 2009 (i.e. 24.3% were under 18 years old, and 6.4% were children under 5 years old). The totality of the population is considered rural. Agriculture, forestry, fishing, hunting, and mining accounted for 25% of employment opportunities in Knox County between 2005 and 2009, representing the main source of employment in the county.

The Brazos River extends over approximately 48.5 miles in Knox County, along agricultural fields. The largest populated area is Munday City with an estimated population of 1,266 in 2009. Other smaller populated areas include Knox City (850 residents), Benjamin (259 residents), and Goree (230 residents). The closest populated area to the Brazos River is Knox City, which is approximately 3.7 mi from the river.

## **Baylor County**

This county covers 870.77 square miles and had an estimated population of 3,677 (4.7 persons/mi<sup>2</sup>) in 2009. The population has decreased by 10.2% since 2000 and by 29.6% since 1970 (Fig. 9). Infants and young accounted for nearly a quarter of the total population in 2009 (i.e. 22.7% were under 18 years old, and 6.4% were children under 5 years old). Agriculture, forestry, fishing, hunting, and mining accounted for 10% of employment opportunities in Baylor County between 2005 and 2009. These employment opportunities represented the third main source of employment after educational services, health care and social assistance occupations (21%), and public administration (16%).

The Brazos River extends over approximately 42.7 miles in Baylor County, mostly along agricultural fields. The river passes by the western side of Seymour, which is the largest urban area with an estimated population of 2,711 in 2009.

## **Throckmorton County**

This county covers 919.34 square miles and had an estimated population of 1,593 (2.0 persons/mi<sup>2</sup>) in 2009. The population has decreased by 14% since 2000 and by 27.8% since 1970 (Fig. 9). Infants and young accounted for nearly a quarter of the total population in 2009 (i.e. 20.2% were under 18 years old, and 4.4% were children under 5 years old). The totality of the population is considered rural. Agriculture, forestry, fishing, hunting, and mining accounted for 35% of employment opportunities in Throckmorton County between 2005 and 2009, representing the primary source of employment in the county.

The Brazos River extends over approximately 18.6 miles in Throckmorton County, along agricultural fields. The largest populated area is the town of Throckmorton with an estimated population of 768 in 2009. Other smaller populated areas include the town of Woodson (304 residents). Throckmorton is the closest populated area to the Brazos River in the county and is located approximately 14.3 mi from the river.

## **Young County**

This county covers 922.33 square miles and had an estimated population of 17,792 (19.5 persons/mi<sup>2</sup>) in 2009. The population has decreased by 0.8% since 2000 but has increased by 15.5% since 1970 (Fig. 9). Infants and young accounted for a quarter of the total population in 2009 (i.e. 25.2% were under 18 years old, and 6.7% were children under 5 years old). Agriculture, forestry, fishing, hunting, and mining accounted for 14% of employment opportunities in the county between 2005 and 2009. These jobs are the third main source of employment after educational services, health care and social assistance occupations (18%), and retail trade (15%).

The Brazos River extends over approximately 83.9 miles in Young County, along agricultural fields. The largest urban area is Graham City with an estimated population of 8,522 in 2009. Other smaller urban areas include Olney (3,260 residents) and Newcastle (422 residents). The

river passes through the western portion of New Castle, and is 0.96 mi away from the southern limit of Graham City.

### **Current Land Use and Changes Since 1970**

Current land use data of all lands within 1 km of the Brazos River were obtained from the United States Geological Survey (USGS) National Land Cover Dataset (NLCD) (2006). Derived from Land-sat Thematic Mapper satellite data, the NLCD is a classification scheme for land cover applied consistently over the United States. The spatial resolution of the dataset is 30 meters. Land uses were grouped into seven Anderson Level I land use classifier categories (Fry et al. 2009). Current (i.e., 2006) land uses for all lands within 1 km of the Brazos River are shown in Figures 10, 11, 12, and 13.

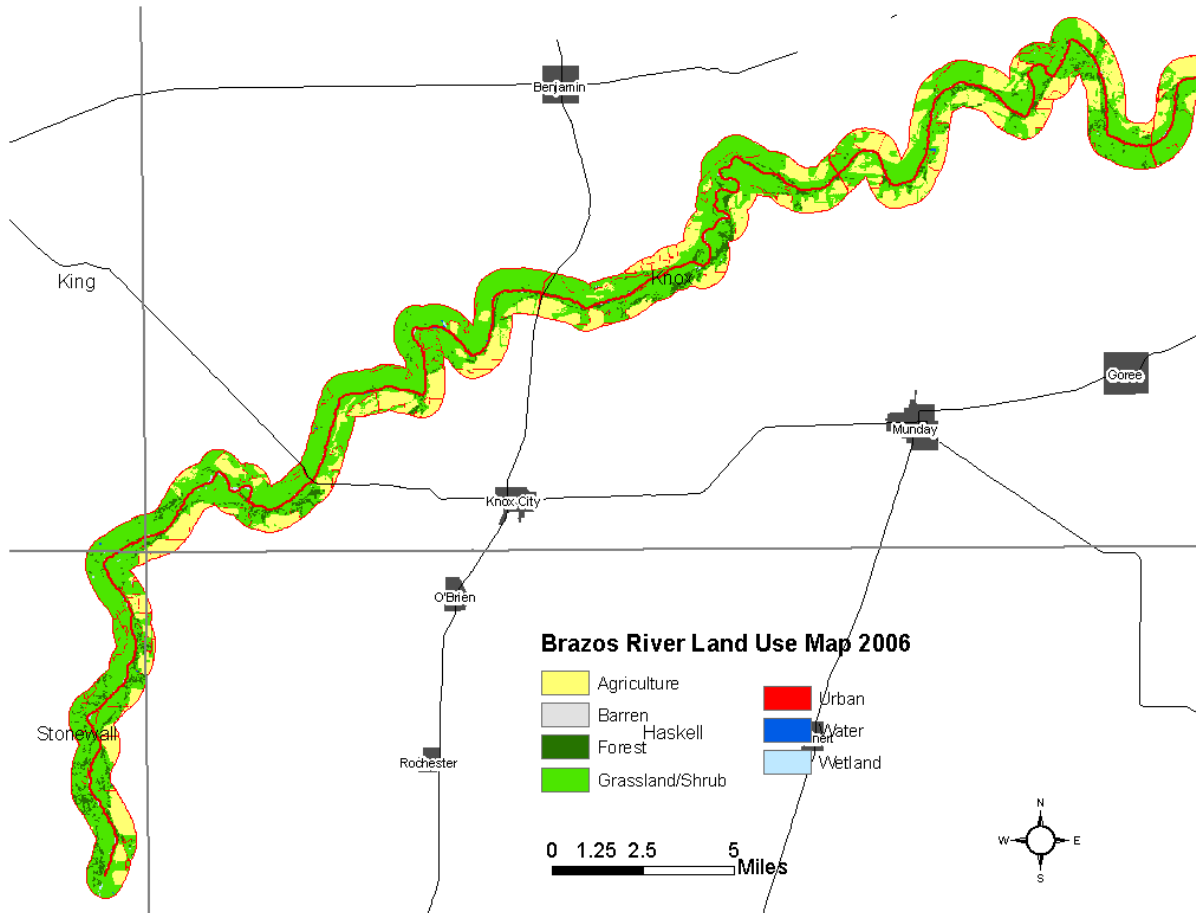


Figure 10. Land uses of the Brazos River based on the 2006 USGS National Land Cover Dataset (1 of 4).

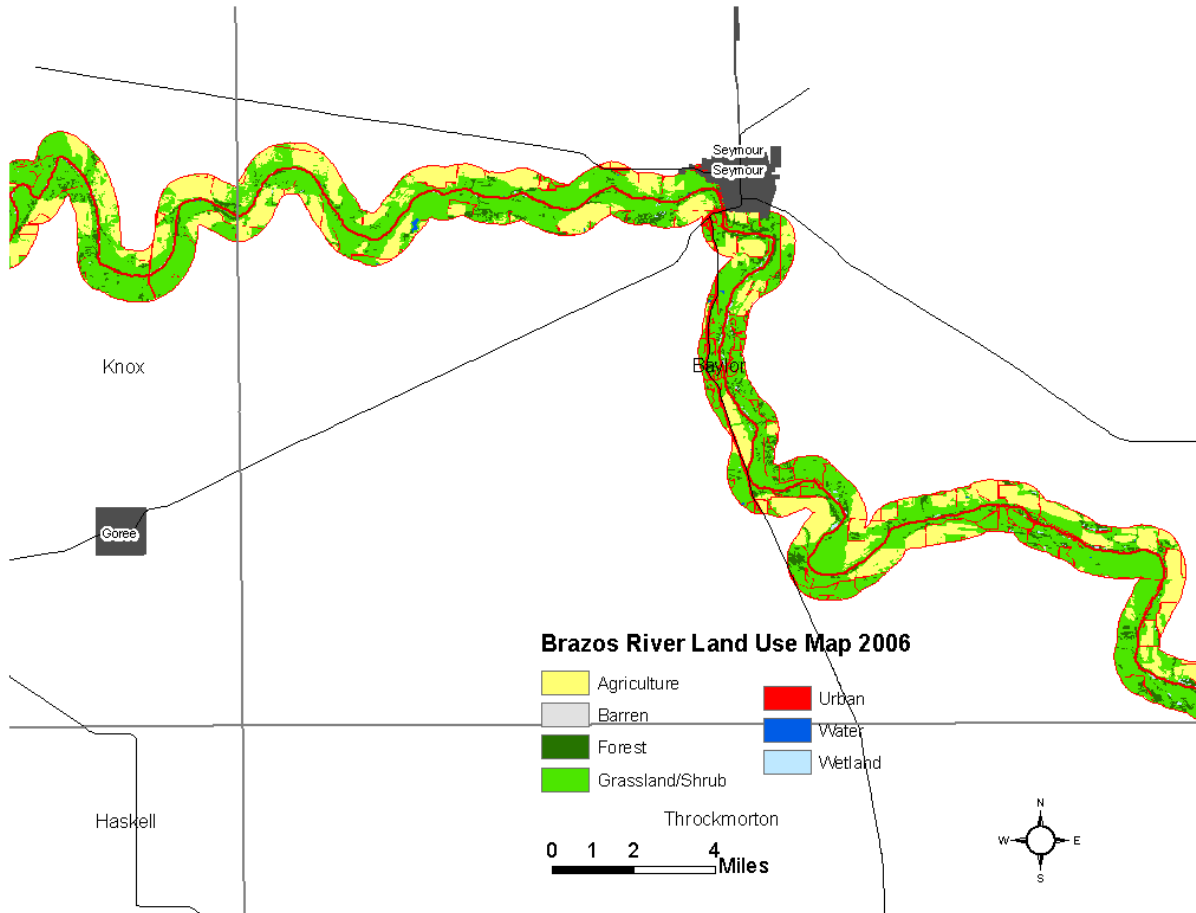


Figure 11. Land uses of the Brazos River based on the 2006 USGS National Land Cover Dataset (2 of 4).

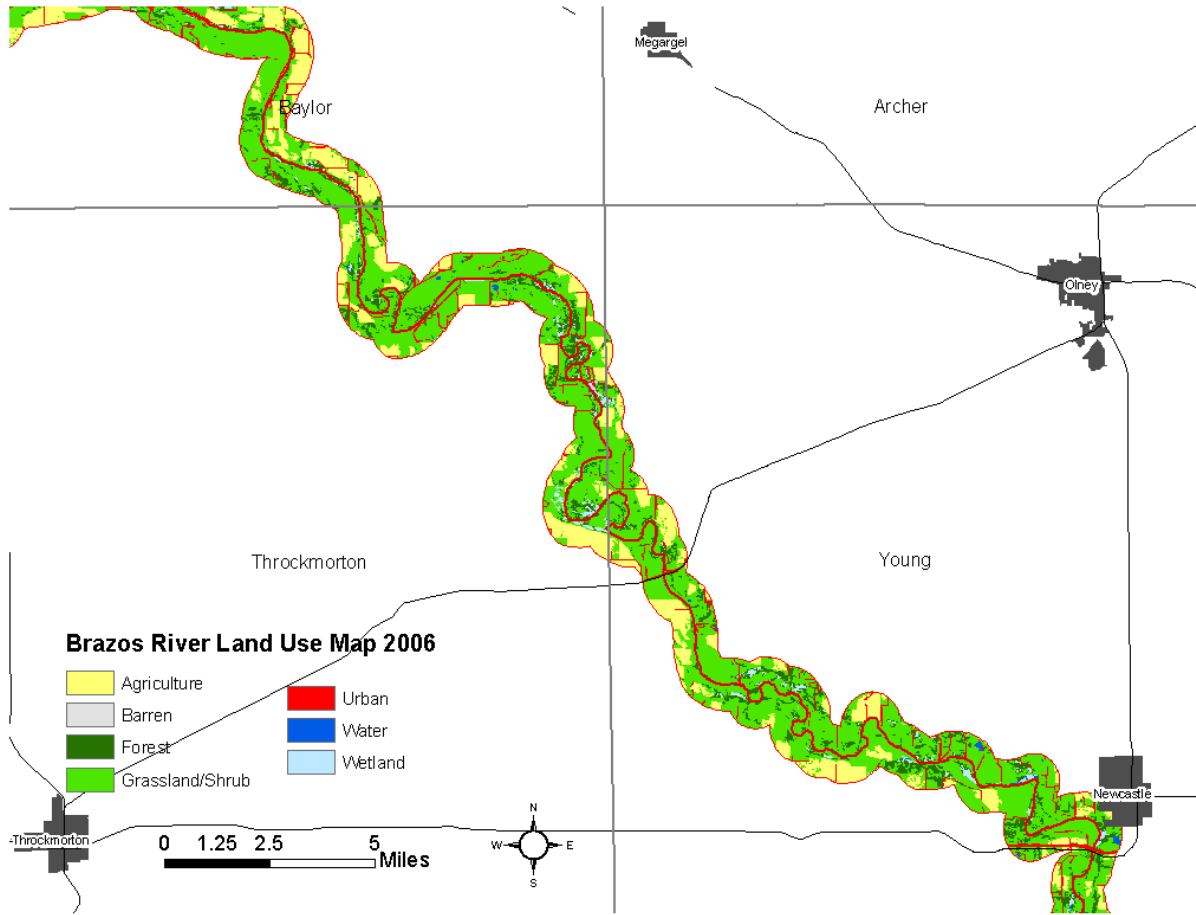


Figure 12. Land uses of the Brazos River based on the 2006 USGS National Land Cover Dataset (3 of 4).

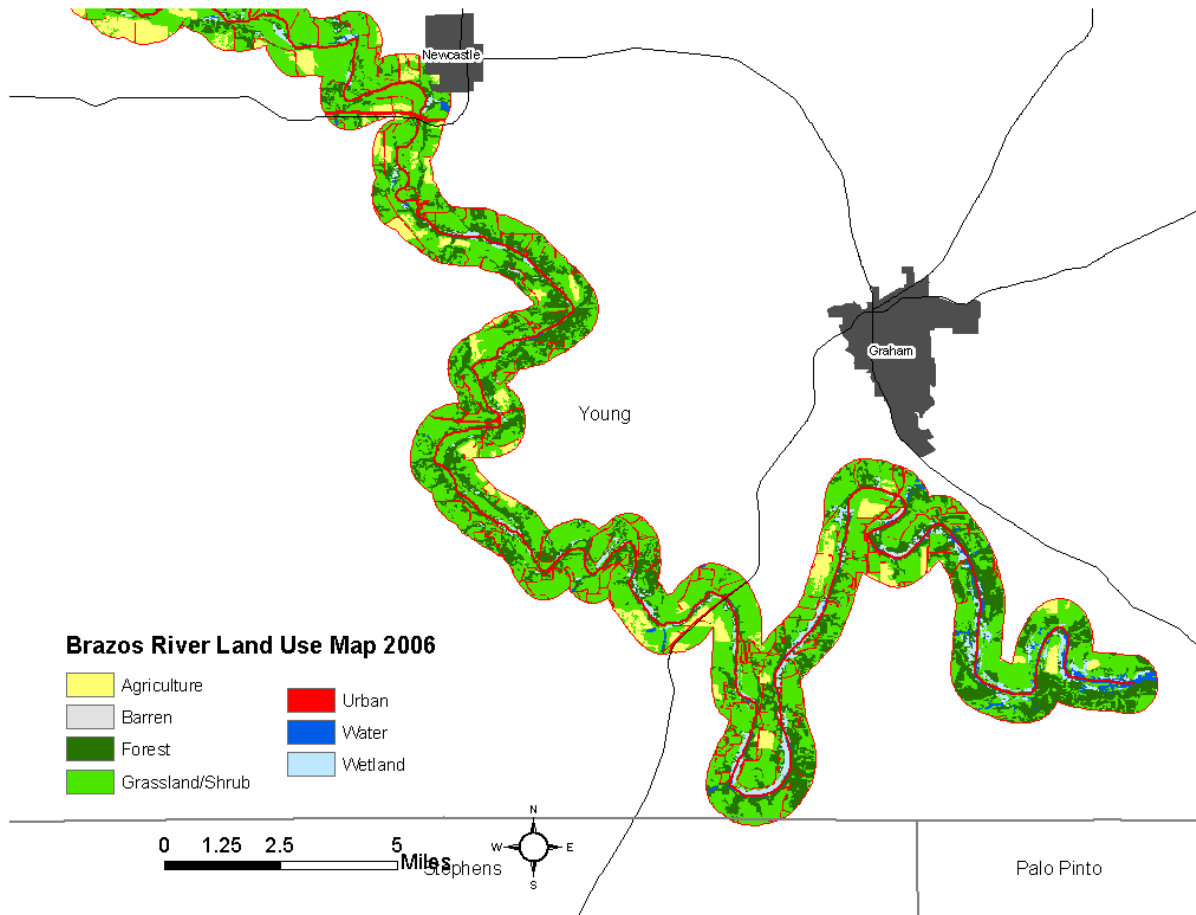


Figure 13. Land uses of the Brazos River based on the 2006 USGS National Land Cover Dataset (4 of 4).

Grassland/shrub, agriculture, and forest land uses accounted for 59.6%, 19.4%, and 12%, respectively, of the total land use within 1 km of the Brazos River (Figure 14). Urban areas accounted for 4.9% of the total followed by wetlands (2%), water (1.9%) and barrens (0.2%).

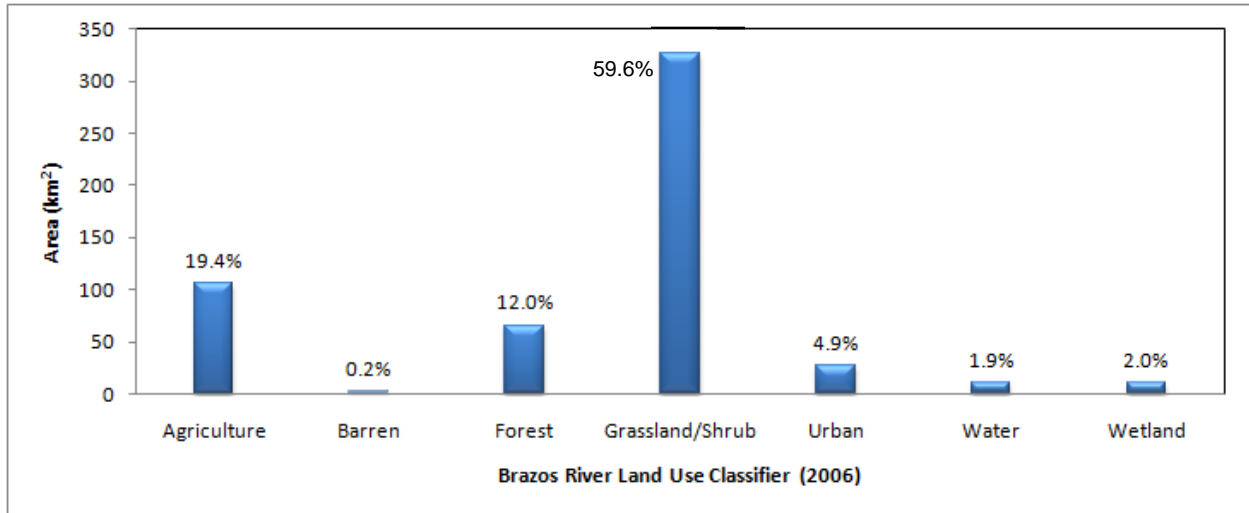


Figure 14. Total land area and percentage of the total for each land use classifier category for all lands within 1km of the Brazos River in 2006.

The GIRAS Land Use Land Cover Dataset (1970) was obtained from the USGS and used to characterize historic land use within a 1 km of the Brazos River (Figure 15-18). ESRI ArcMap's Spatial Analyst was used to quantify the changes in land use from the 1970 to 2006. Figures 19 to 22 show all the lands adjacent to the Brazos River that have changed in their land use classifier category from 1970 to 2006.



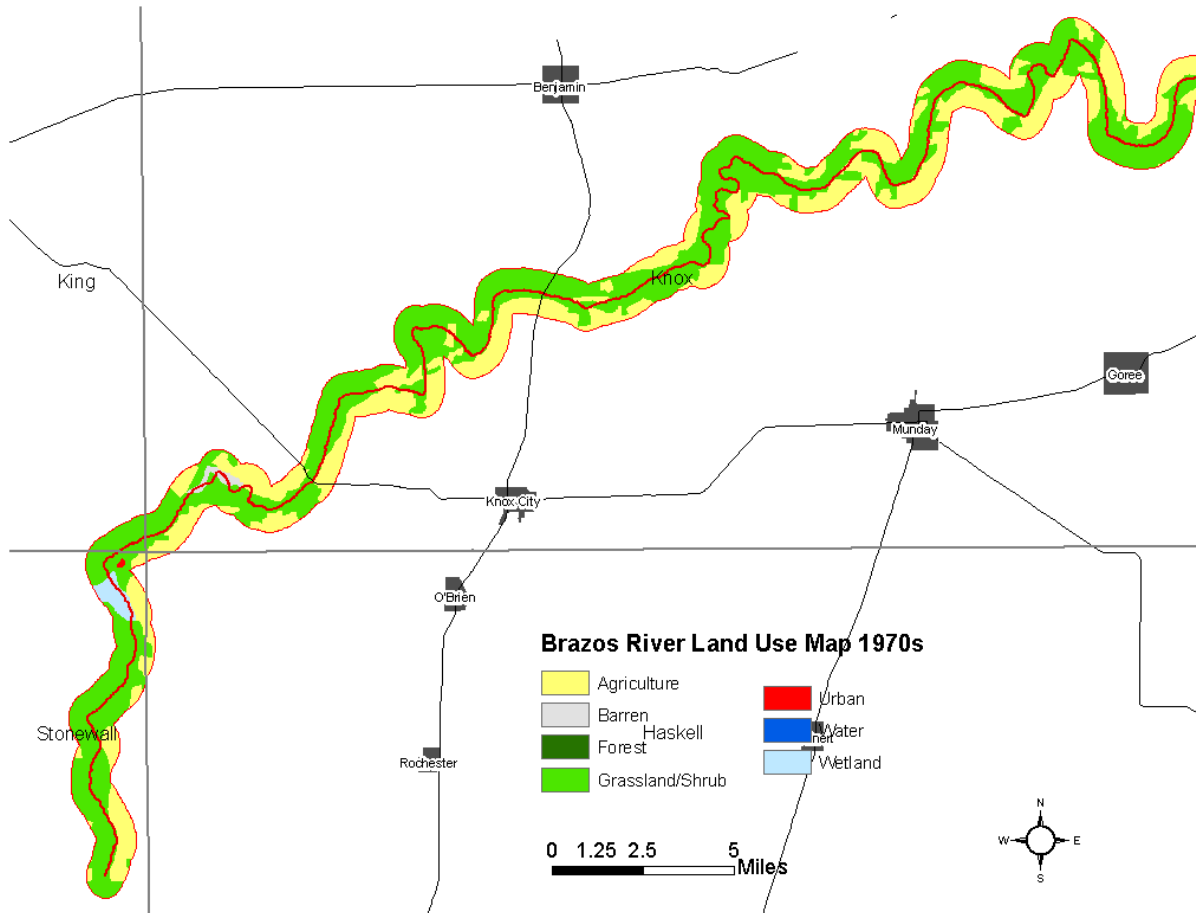


Figure 15. Land uses of the Brazos River based on the 1970 GIRAS Land Use Land Cover Dataset (1 of 4).

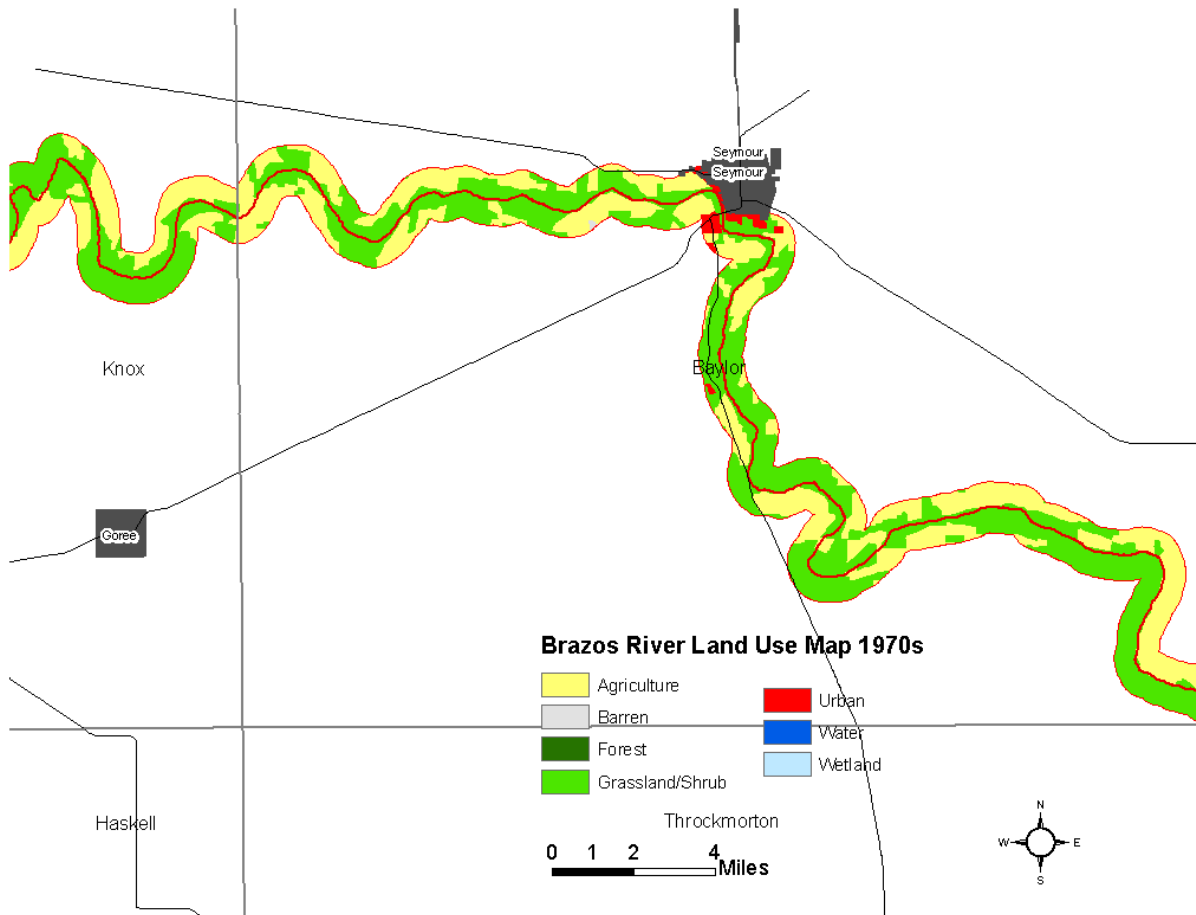


Figure 16. Land uses of the Brazos River based on the 1970 GIRAS Land Use Land Cover Dataset (2 of 4).

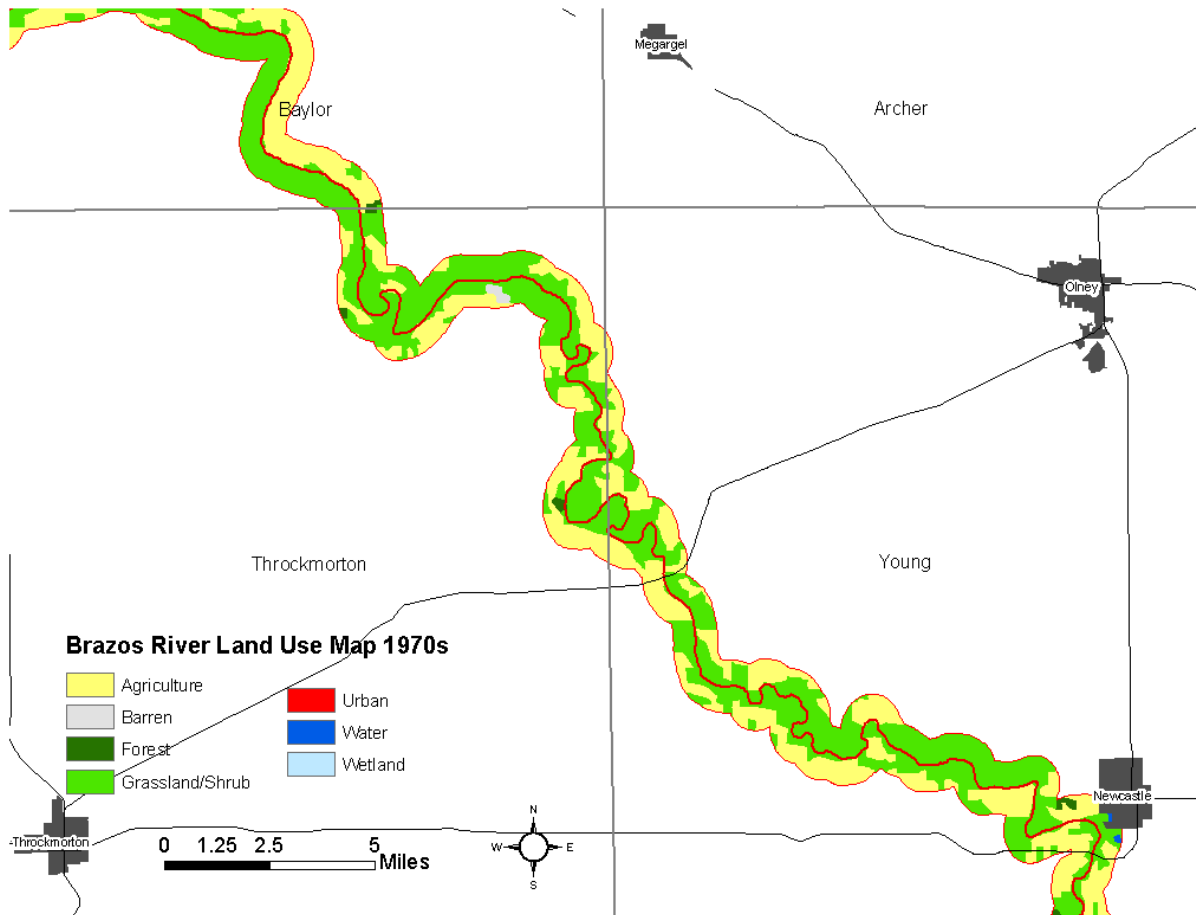


Figure 17. Land uses of the Brazos River based on the 1970 GIRAS Land Use Land Cover Dataset (3 of 4).

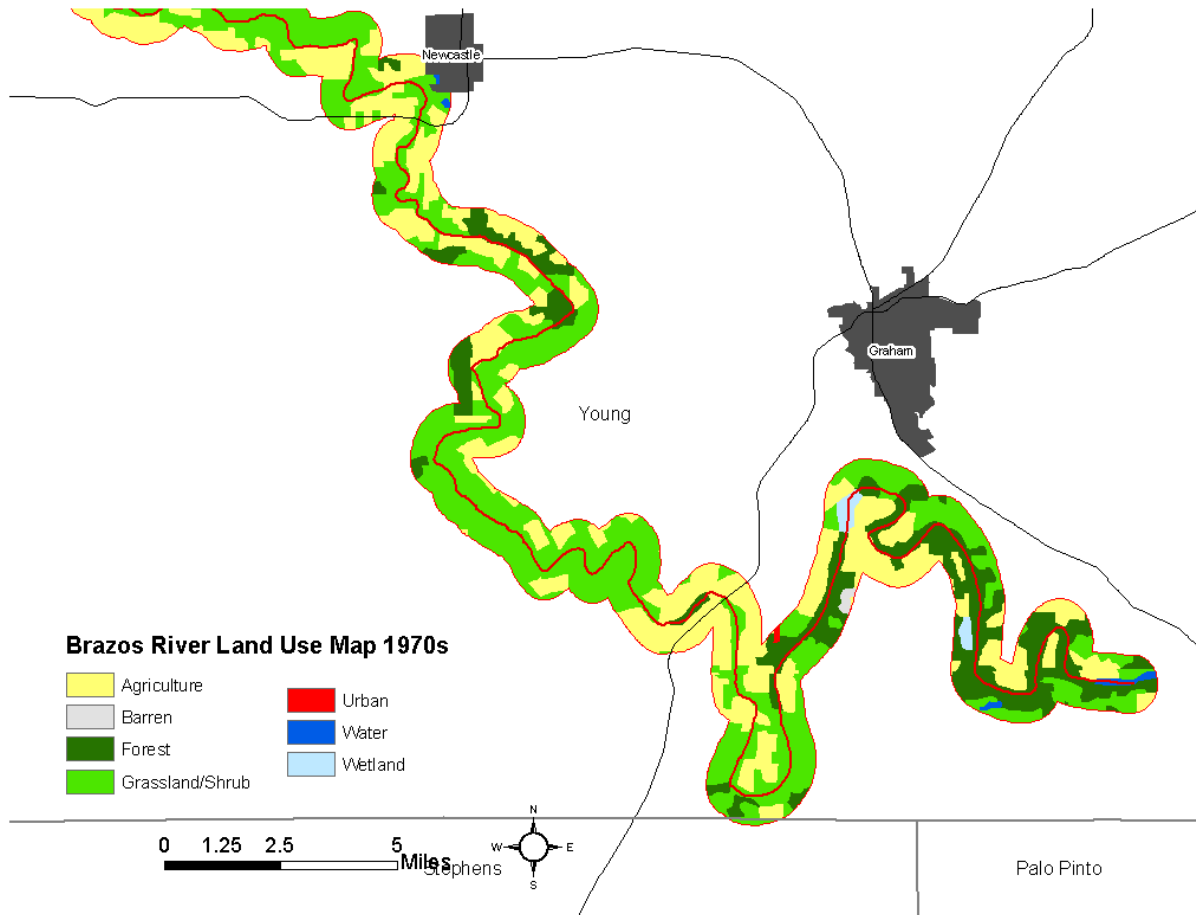


Figure 18. Land uses of the Brazos River based on the 1970 GIRAS Land Use Land Cover Dataset (4 of 4).

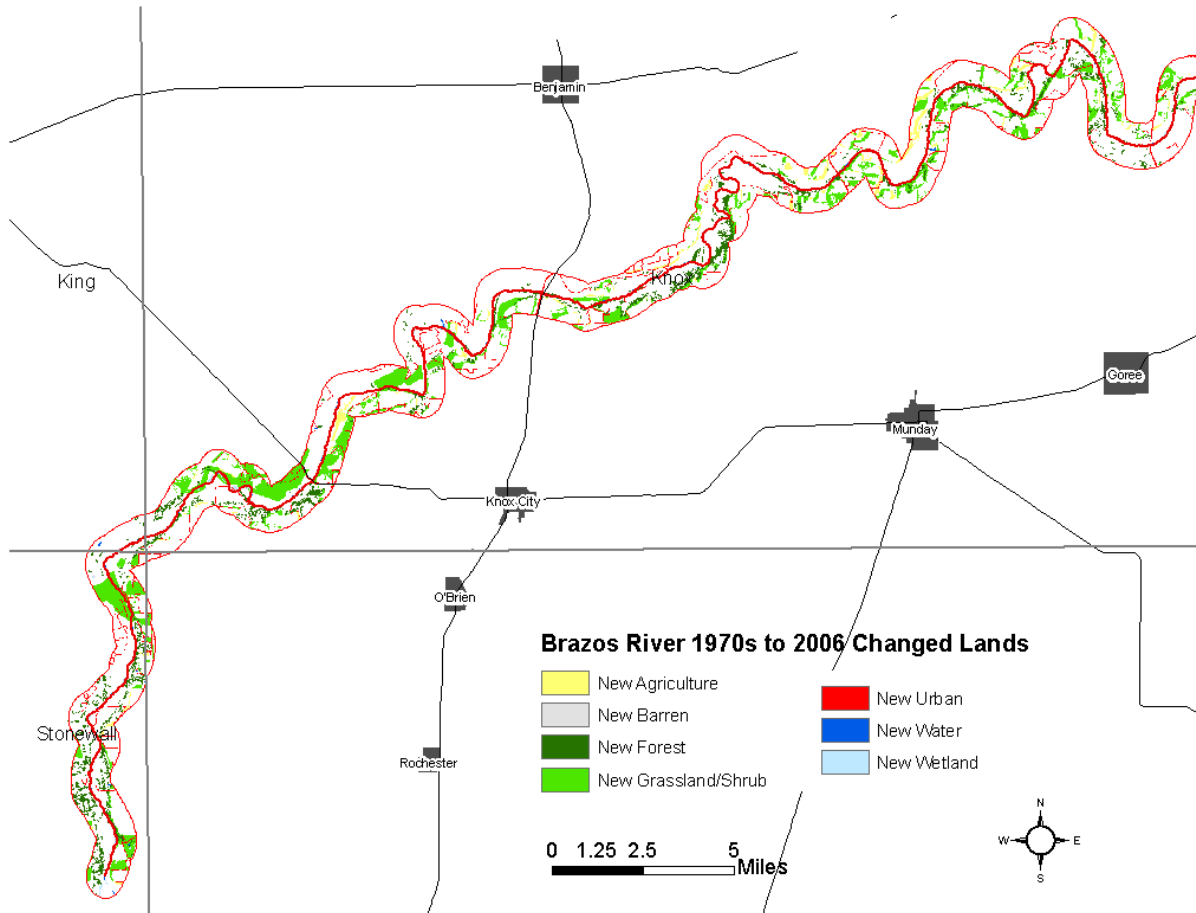


Figure 19. Map of all lands adjacent to the Brazos River that have changed in their land use classifier category from 1970 to 2006. Changes based on the 1970 GIRAS Land Use Land Cover Dataset and the 2006 USGS National Land Cover Dataset (1 of 4).

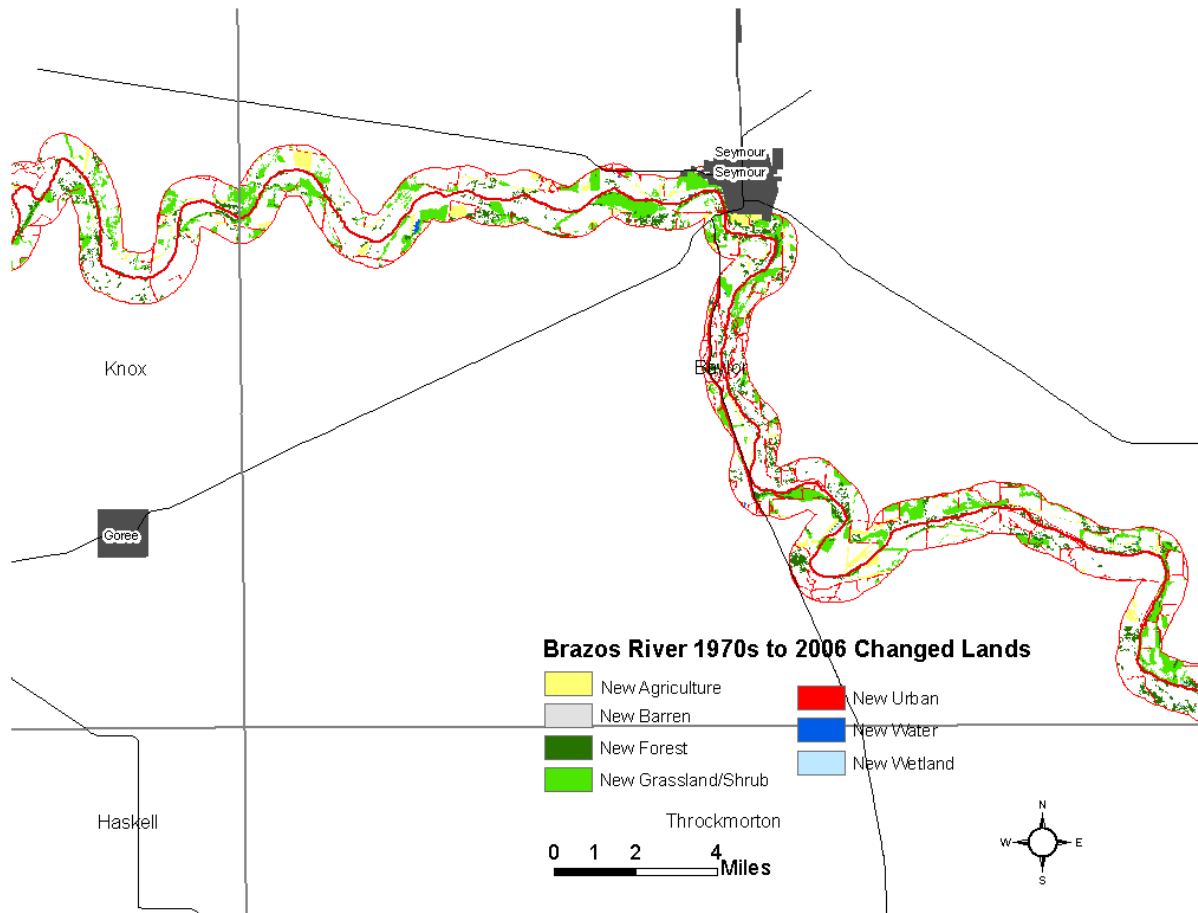


Figure 20. Map of all lands adjacent to the Brazos River that have changed in their land use classifier category from 1970 to 2006. Changes based on the 1970 GIRAS Land Use Land Cover Dataset and the 2006 USGS National Land Cover Dataset (2 of 4).

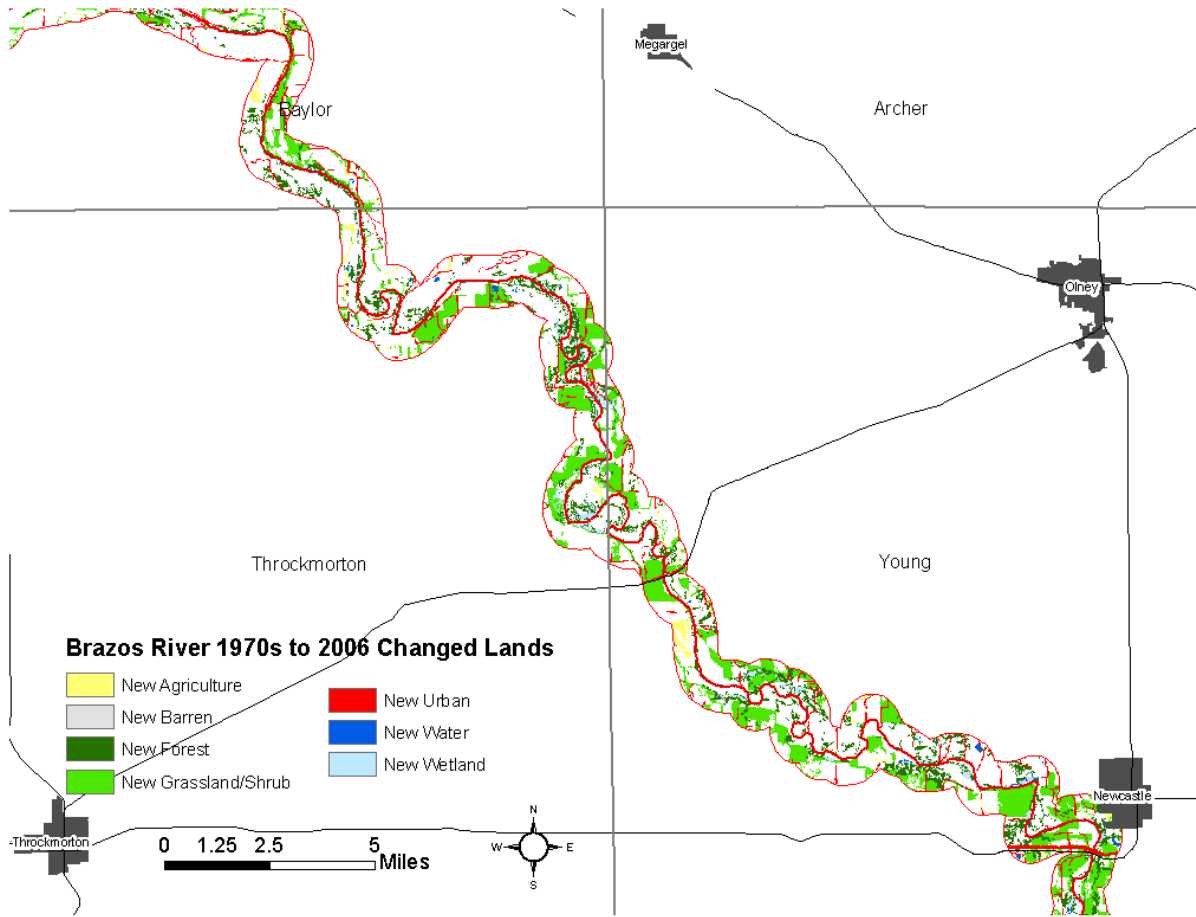


Figure 21. Map of all lands adjacent to the Brazos River that have changed in their land use classifier category from 1970 to 2006. Changes based on the 1970 GIRAS Land Use Land Cover Dataset and the 2006 USGS National Land Cover Dataset (3 of 4).

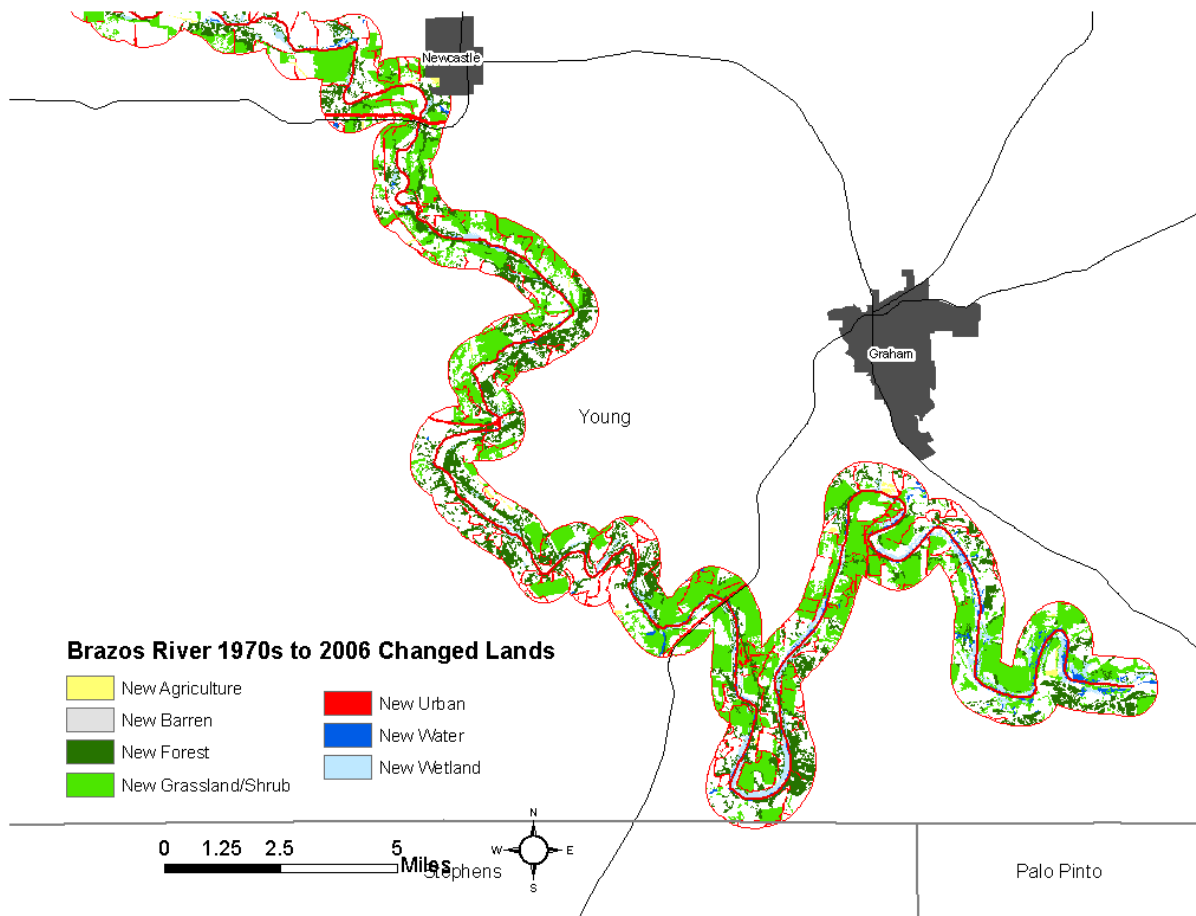


Figure 22. Map of all lands adjacent to the Brazos River that have changed in their land use classifier category from 1970 to 2006. Changes based on the 1970 GIRAS Land Use Land Cover Dataset and the 2006 USGS National Land Cover Dataset (4 of 4).

From 1970 to 2006, agriculture decreased by 17.6% (Figure 23). Forest increased overall by 6.6%. Urban areas, grassland/shrub forests, water, and wetlands increased in area by 4.2 %, 3.7%, 1.8%, and 1.4%, respectively. Barrens decreased by 0.1%.



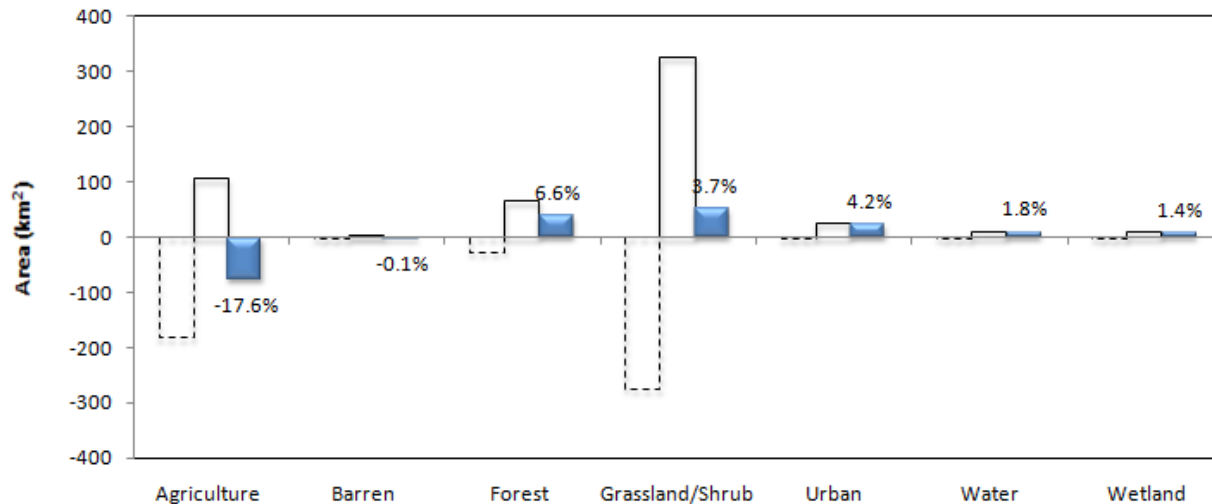


Figure 23. Changes in land use area (gross losses=dashed bars, gross gains=solid white bars, net change=colored bars with percentages) for the Brazos River from 1970 to 2006.

### Historical Accounts of Recreation

The purpose of this review is to provide a historical account of recreational use that focuses on the period from the early seventies, when the clean water act was created, to the present; but also to provide a general overview of the historical significance of the Brazos River (1208) in terms of recreation to the people of Texas. In order to carry out this task we conducted a review of publications that provide information related to the recreational potential (e.g., fishing, hunting, and/or paddling) of streams and rivers in Texas. We also reviewed monographs on the history of individual counties associated RUAA streams, as well as other documents that could contain historical information on recreation. The majority of the consulted references provided little relevant information. We, however, were able to obtain some important information that is summarized below. In addition to the cited references, we provide a list of the references that were reviewed but are not cited in the text in Appendix 6.

Most of literature on the recreational potential of rivers in Texas, that include a section on the Brazos River, focus on portions of the river below the Possum Kingdom Reservoir. The THSC (1940) *Texas: a Guide to the Lonestar* has a road trip (i.e. Tour 27) to North Central Texas that

stars at the junction of highways US 380 and US 277 and includes points along the Brazos River (1208). The tour gives information on geology, wildlife, and vegetation of the region as well as specific characteristics of the landscape at the confluence of Double Mountain Fork and Salt Fork. Belisle and Josselet (1974) in their *Analysis of Texas Waterways*, published by the Texas Parks and Wildlife Department, include a section on the Upper Brazos River, from the confluence of Double Mountain Fork and Salt Fork in Stonewall County to Possum Kingdom (i.e.1208). They describe the stretch as a meandering river, with intermittent large sand banks and steep banks, running through a “semi-arid farming and ranching country”. They also state that only the last 25 miles of segment 1208 has enough water for recreation. This portion of 1208 starts at the confluence of Clear Fork and the Brazos River, in Young County, and ends at Possum Kingdom Reservoir. This information is confirmed in Kirkley’s (1983) *Guide to Texas Rivers and Streams*. Ruff (1990), in her book *Texas Water Recreation*, makes reference to the stretch of river that was the location of John Graves’ canoeing trip that inspired his book *Goodbye to a River*, as the most scenic portion of the river, characterized by clear sea-green colored water. She described the river above Possum Kingdom as being “dreary, dirty brown” and does not mention recreational opportunities there.

Anecdotal accounts of recreation in the Upper Brazos during the late 1800s and early 1900s includes one by Mrs. W. T. Britton from Baylor County in which she described a 4<sup>th</sup> of July picnic that took place along the bank of the river in 1883. The picnic extended over three days during which the invited families camped along the river, fed on fish and wildlife, played games, and danced (Britton, 1955). James Daniel Culver from Baylor County recalled hunting, fishing, and swimming in the Brazos River at the ages of 14 to 15 years old (i.e. between 1914 to 1915). He mentioned that there was a community swimming hole in the river of eight to ten feet in depth during low level stream flow. He recalled that his brother and various friends use to swim together: “We had an exciting time when the river was high. Each of us will catch a big log that will float down the river and when all of us had one we would get astride of our logs and down the river we would go at a fast pace, then the big job would be to get back up to the river hole where we had our clothes hidden. We had grass burrs and bull nettles which would sting our bare legs and the hot sand and the plum thickets to come through without clothing on. On one occasion there were women and children picking wild plums and we had to detour quite a ways to get past them without being seen nude. Was it worth it? Sure it was, it made history to us

mixed with misery but it was fun and it was dangerous traveling down the fast stream with high rolling waves to overcome” (Baylor County Historical Society, 1972). In the history of the Hanus family of Baylor County there is a passage on how the settlers in the late 1890s used to catch fish by seining the Brazos River or by hand in holes under the river bank. They caught fish that were as large as 75 pounds. There is another anecdote from the early 1890’s in which members of the family were paddling and playing on the river sand and saw one or two wolfs and heard the call of a panther (Baylor County Historical Society, 1972).

As it was mentioned above in the memories of James Daniel Culver, wild plums have been an important fruit resource along the banks of the Brazos River (Photograph 1). Up to the present time, patches of plum bushes are very common along the segment and in some areas are dominant. Another anecdote from the early 1890’s by Olen Frances Coffman of the Wirz Family of Baylor County, tells how she and her sister and aunt will go in day trips to a nearby plum patch during the summer, bringing enough fruit to make jelly for the entire winter (Baylor County Historical Society, 1972). Wild plums continue to be an important fruit resource in the area and are highly appreciated by local residents as well as visitors such as the field technicians of this RUAA.



Figure 24. Wild plum trees with ripe fruits along the Brazos River. Photograph taken at site 108.57 on 6/27/10 during this RUAA.

Baptism ceremonies in the Brazos River were a common practice during the early 1900's. Several photos of baptisms taking place in the Upper Brazos River can be viewed in *The Portal to Texas History*, a website hosted by the University of North Texas (<http://texashistory.unt.edu/>). Gray's (1963) collection of stories of the "Early Days in Knox County" has a photograph of a baptism in the Brazos River near Munday in Knox County, which is located within segment 1208.

Despite of the paucity of published accounts of recreational activities and information concerning recreational opportunities along the upper Brazos River, interviews of landowners and local residents conducted in the field during the RUAA surveys, and over the phone provide a good account of historical recreational use in segment 1208. Please see the Recreational Use Interviews section contained in the Results of the report.

### **Unclassified Water Body 1210A (Navasota River Above Lake Mexia):**

The Navasota River derives its name from the Indian name of Nabasoto. The river originates near Mount Calm in Hill County and flows 125 miles southeast to its confluence with the Brazos River. The extent of the watershed is approximately 2,235 square miles in area (The Handbook of Texas Online, 2011).

The Navasota River Above Lake Mexia (1210A) is located within the USGS Hydrologic Unit 12070103: Texas-Gulf Region > Lowe Brazos Subregion > Navasota. This hydrologic unit, or watershed, encompasses approximately 2,260 square miles (Seaber et al. 1994) in North Central Texas (Appendix 1).

### **Climate**

The Navasota River (1210A) is located within the Central Texas Climate Division (i.e. division No. 3, NOAA 2005). Moisture conditions in the Central Texas Climate Division were described above (Fig. 7, 8).

Temperature in the surrounding area of the Navasota River has a pattern of longer summers and shorter cold seasons in comparison with the upper portion of the Central Texas Climate Division (See Fig. 5 and 6). The weather in this area is characterized by persistent hot temperatures from May to October, with monthly maximum temperatures over 80 °F (Fig. 25). The highest average rainfall occurs in May (i.e. 4.7 inches) followed by another rainy season in the fall between September and October (i.e. 4.2–4.3 inches; Fig. 26). The driest month of the year is July with < 2 inches average rainfall. The cool season extends from December to January with monthly minimum temperatures under 40 °F (Fig. 25) and average rainfall between 3.8 to 2.4 inches (Fig. 26).

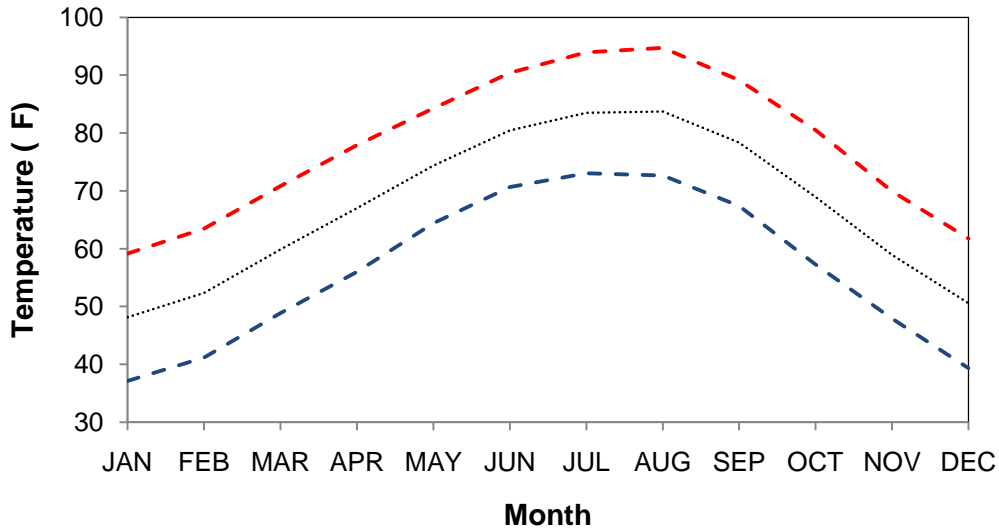


Figure 25. Monthly average normal minimum (blue dashed line), mean (dotted line) and maximum temperatures (red dashed line) for Mexia City, Limestone County, Texas (Jan 1970 – Oct 2010); Data from NOAA 2011).

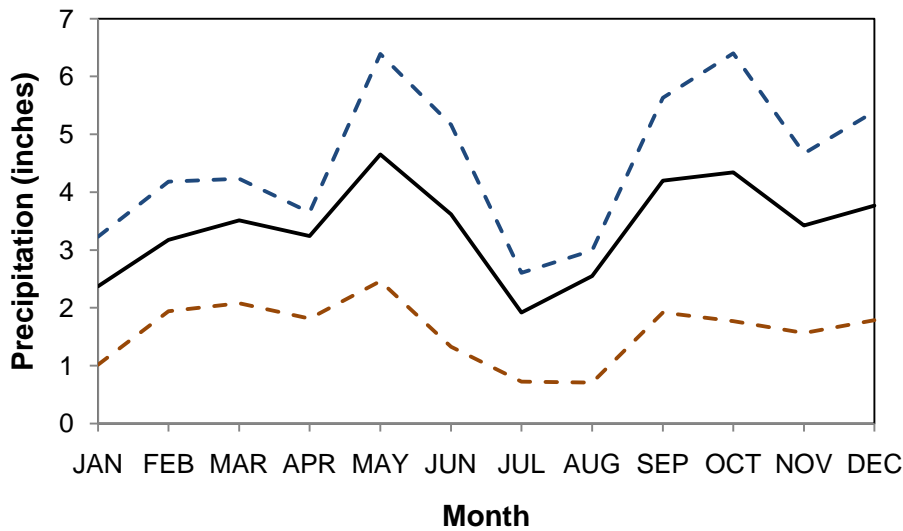


Figure 26. Monthly average 25<sup>th</sup>-percentile (lower dashed line), mean (solid line), and 75<sup>th</sup>-percentile (upper dashed line) precipitation for Mexia City, Limestone County, Texas (1970 – 2010); Data from NOAA 2011).

## **Local Population**

The Navasota River (1210A) flows through Hill and Limestone counties. General descriptions of county local populations are presented below and are based on data from the United States Census Bureau. Otherwise stated, population estimates and statistics represent averages between January 2005 and December 2009 (Census 2011).

### **Hill County**

This county covers 962.36 square miles and had an estimated population of 35,840 (33.6 persons/mi<sup>2</sup>) in 2009. The population has increased by 10.9% since 2000 and by 58.6% since 1970 (Fig. 27). Infants and young accounted for a quarter of the total population in 2009 (i.e. 25% were under 18 years old, and 7.0% were children under 5 years old). Agriculture, forestry, fishing, hunting, and mining accounted for 5% of employment opportunities in the county between 2005 and 2009. These economical activities were equally as important as professional, scientific, management, and waste-management services. These activities represented the fifth largest source of employment in Hill County after educational services, health care and social assistance activities (20%), construction (13%), retail trade (13%), manufacturing (12%), arts, entertainment, recreation, accommodation and food services (8%), and transportation, warehousing, and utilities (8%).

The Navasota River (1210A) extends over approximately 3.82 miles in Hill County, along agricultural fields. The largest urban area is Hillsboro City that had an estimated population of 8,872 in 2009. Other smaller populated areas include Whitney (2,341 residents), Hubbard (1,544 residents), Itasca (1,292 residents), Blum (550 residents), Abbott (350 residents), Penelope (325 residents), Mount Calm (291 residents), Covington (267), Malone (229 residents), Carl's Corner (221 residents), Bynum (220 residents), Aquilla (119 residents), and Mertens (136). The closest populated area to the Navasota River is Mount Calm, located at approximately 0.85 mi to the river, measured by straight line.

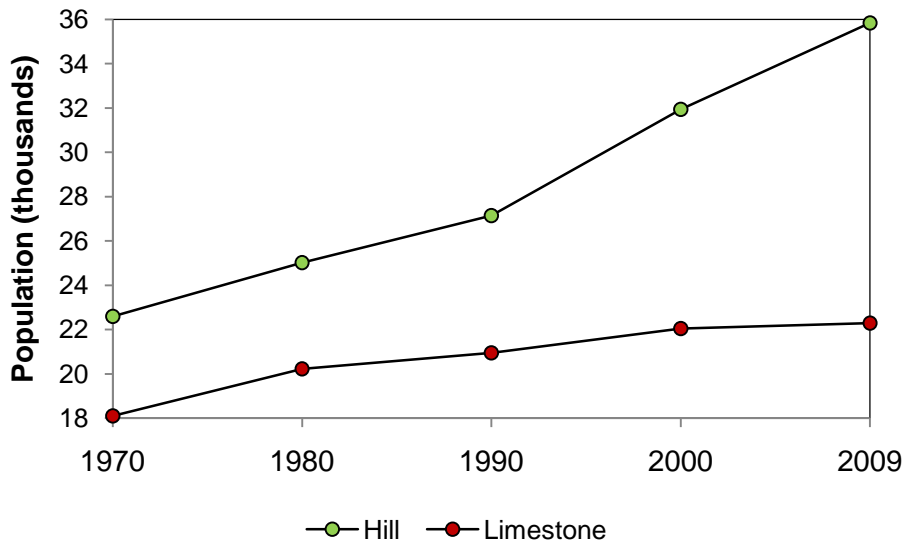


Figure 27. Decennial U.S. Census population values for counties along the Navasota River Above Lake Mexia (1210A), Texas. (Data from Census 2011).

### Limestone County

This county covers 908.88 square miles and had an estimated population of 22,287 (24.3 persons/mi<sup>2</sup>) in 2009. The population has increased by 1.1% since 2000 and by 23.1% since 1970 (Fig. 27). Infants and young accounted for nearly a quarter of the total population in 2009 (i.e. 24% were under 18 years old, and 6.8% were children under 5 years old). Agriculture, forestry, fishing, hunting, and mining accounted for 9% of employment opportunities in Limestone County between 2005 and 2009. These economical activities represented the third main source of employment after educational services, health care and social assistance activities (31%), and retail trade (10%).

The Navasota River (1210A) extends over approximately 4.74 miles in Limestone County, along agricultural fields. The largest urban area is Mexia City with an estimated population of 6,598 in 2009. Other smaller urban areas include Gresbeck (4,304 residents), Coolidge (773 residents), Thomton (495 residents), Kosse (389 residents), and Tehuacana (290 residents). The closest populated area to the Navasota River is Coolidge, located at approximately 4.63 mi to the river, measured by straight line.



## Current Land Use and Changes Since the 1970

Current land use data of all lands within 1 km of the Navasota River were obtained from the United States Geological Survey (USGS) National Land Cover Dataset (NLCD) (2006). Land uses were grouped into seven Anderson Level I land use classifier categories (Fry et al. 2009). Current (i.e., 2006) land uses for all lands within 1 km of the Navasota River are shown in Figures 28.

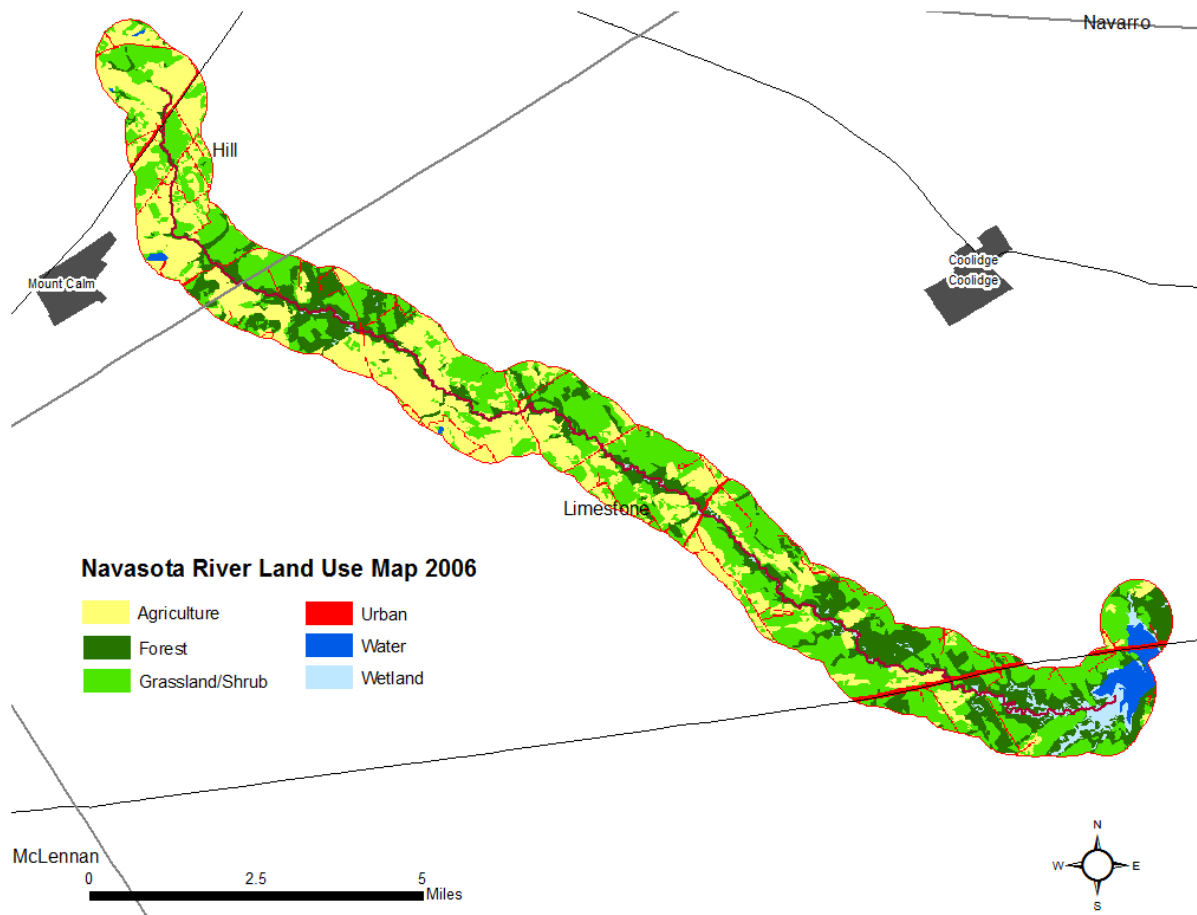


Figure 28. Land uses of the Navasota River based on the 2006 USGS National Land Cover Dataset.

Grassland/shrub, agriculture, and forest land use accounted for 39.1%, 30.5%, and 21.3%, respectively, of the total land use within 1 km of the Navasota River (Figure 29). Urban areas accounted for 4.2%, followed by wetlands (2.9%) and water (2.1%). No barrens occur in this area.

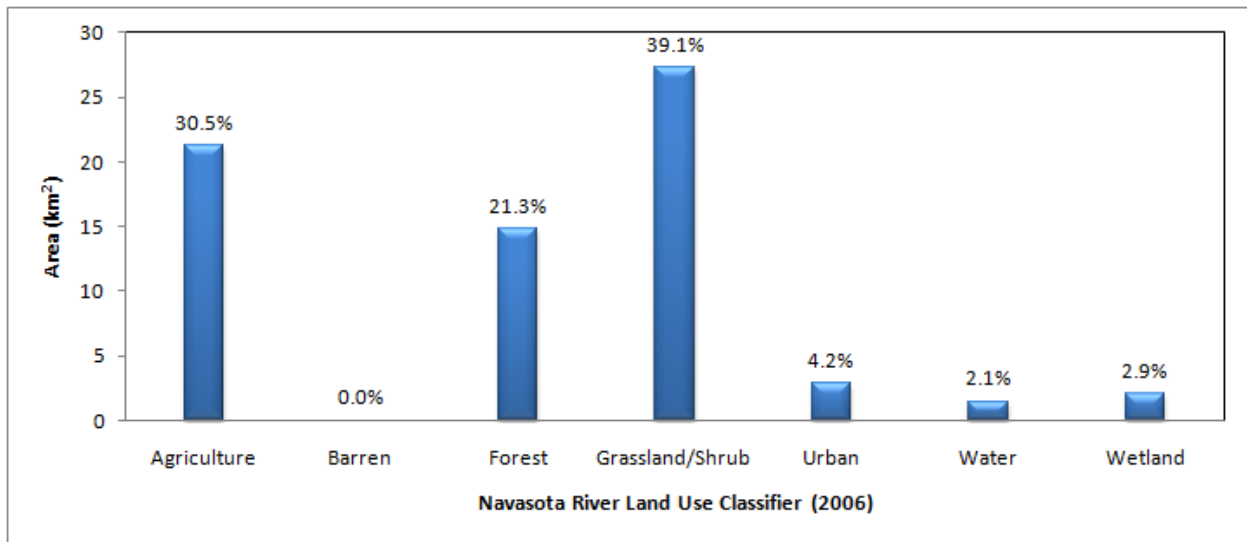


Figure 29. Total land area and percentage of the total for each land use classifier category for all lands within 1km of the Navasota River in 2006.

The GIRAS Land Use Land Cover Dataset (1970) was obtained from the USGS and used to characterize historic land use within a 1 km of the Navasota River (Figure 30). ESRI ArcMap’s Spatial Analyst was used to quantify the changes in land use from the 1970 to 2006. Figure 31 shows all the lands adjacent to the Navasota River that have changed in their land use classifier category from 1970 to 2006.

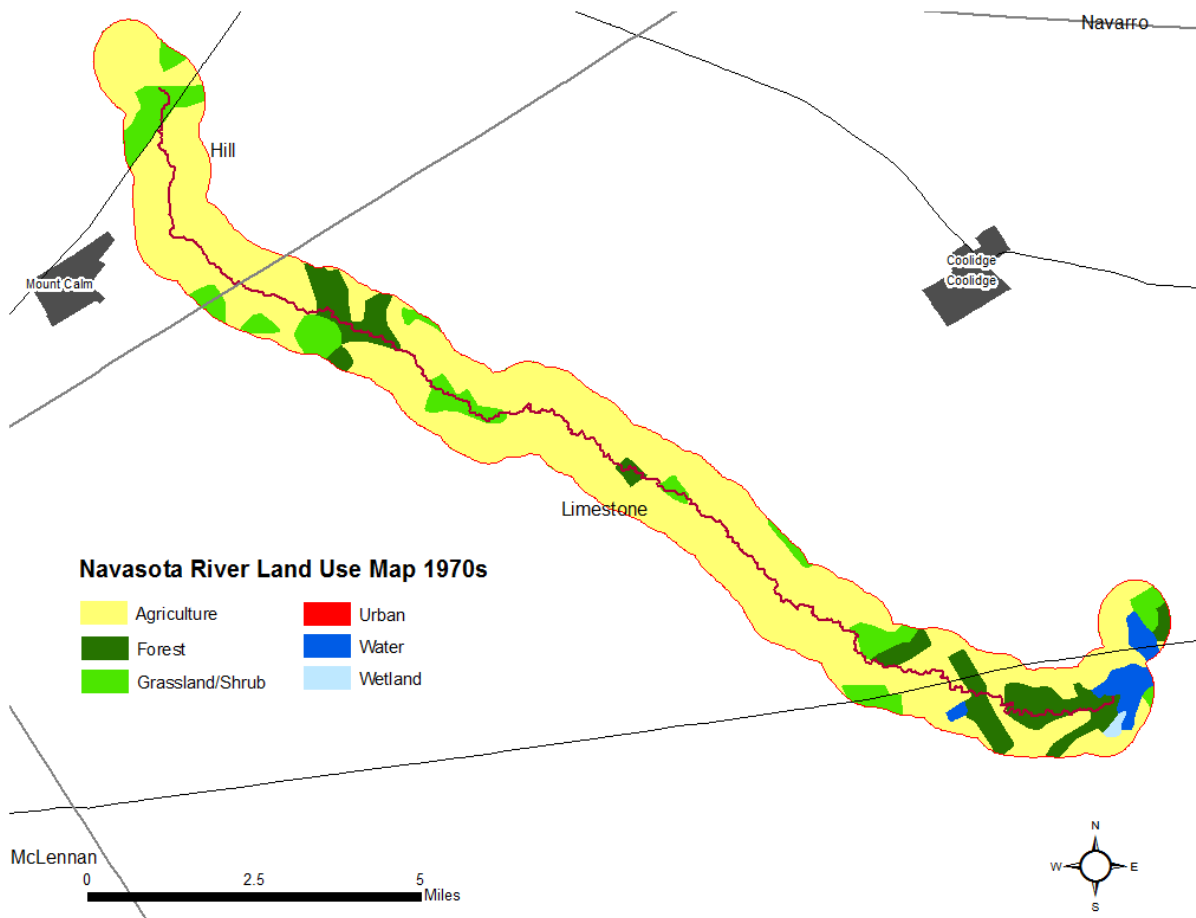


Figure 30. Land uses of the Navasota River based on the 1970 GIRAS Land Use Land Cover Dataset.

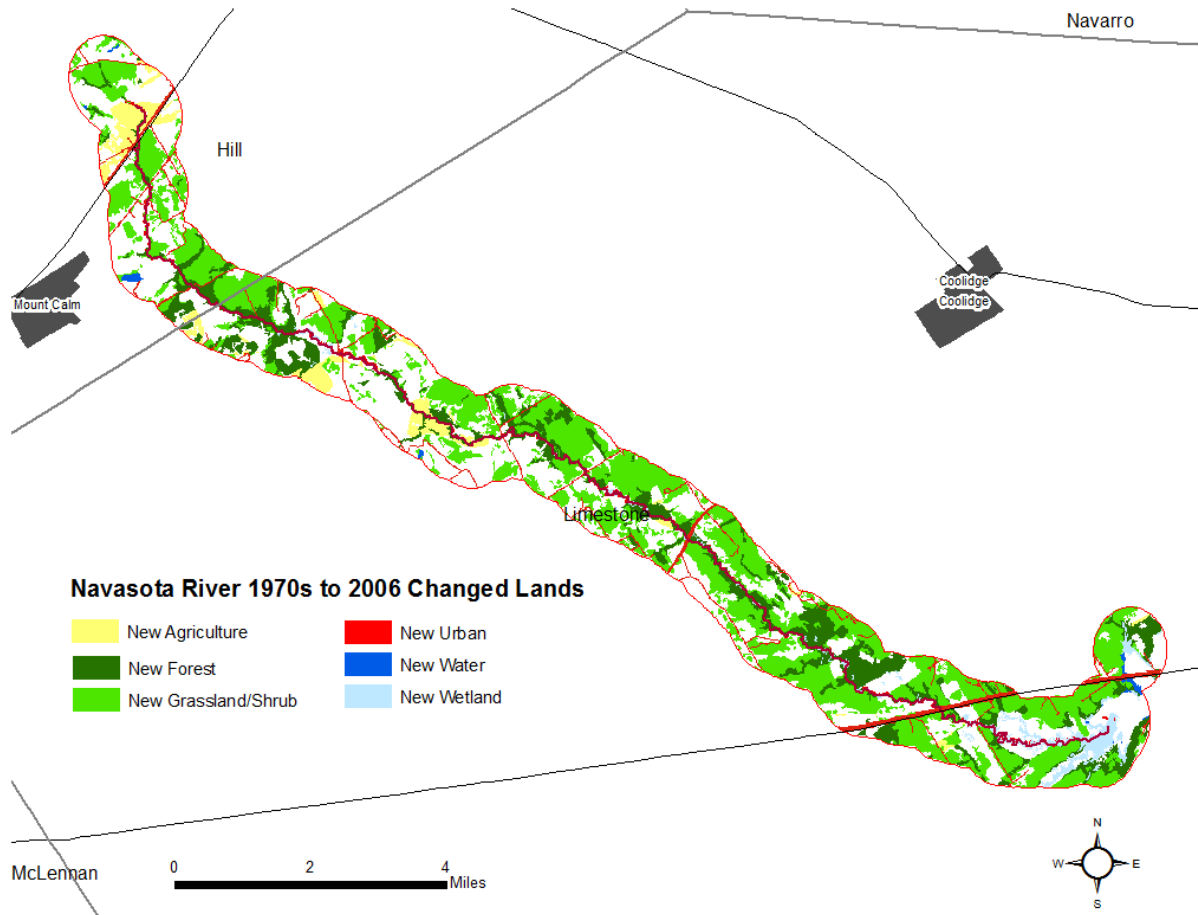


Figure 31. Map of all lands adjacent to the Navasota River that have changed in their land use classifier category from 1970 to 2006. Changes based on the 1970 GIRAS Land Use Land Cover Dataset and the 2006 USGS National Land Cover Dataset.

From 1970 to 2006, agriculture decreased by 45.9% (Figure 32). Grassland/shrub areas increased by 28.7% followed by forest (11%), urban (4.2%), and wetlands (2.6%). Areas of water decreased by 0.5%.

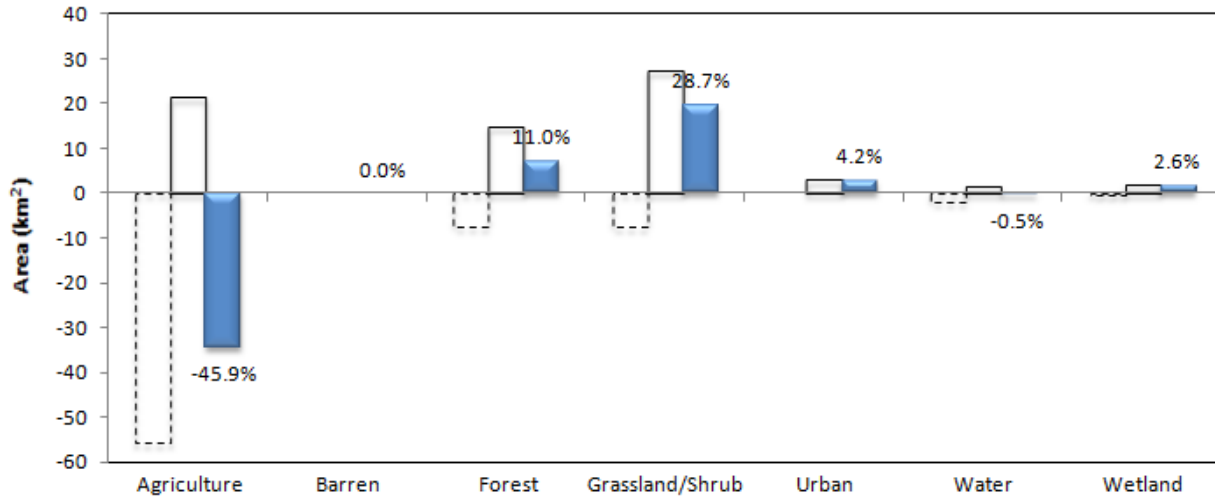


Figure 32. Changes in land use area (gross losses=dashed bars, gross gains=solid white bars, net change=colored bars with percentages) for the Navasota River from 1970 to 2006.

### Historical Accounts of Recreation

The methodology used in this review follows that described for the Brazos River Above Possum Kingdom (1208). Accounts of historical recreation along the Navasota River in the literature are limited and we were unable to find any accounts of recreation that were specific to the upper portion of the river (i.e. 1210A) (see Appendix 6 for a list of the references consulted). Belisle and Josselet (1974) describe the Navasota River as a “natural, free-flowing, narrow stream enclosed by dense hardwood forests”. Although they do not make specific reference to the upper portion of the river, they say that only the lower portion of the river, near to its confluence with the Brazos River, has sufficient flow to support year-around recreation. Clark (1973) describes the upper portion of the Navasota River as intermittent with a few isolated pools, surrounded by cleared land for agriculture or savannah grassland. Fish diversity in the portion of the Navasota River (1210A) ranges from 7 to 7.5 species (average calculated from 5 and 8 sampling stations, starting at U.S. 84, respectively; Rozenburg et al., 1972; Clark, 1973). Gamefish reported for the Navasota River (1210A) include the American gizzard shad (*Dorosoma cepedianum*), Black bullhead (*Ictalurus melas*), Channel catfish (*Ictalurus punctatus*), Green sunfish (*Lepomis cyanellus*), Largemouth bass (*Micropterus salmoides*), White crappie (*Pomoxis annularis*), and

Yellow bullhead (*Ictalurus natalis*) (Rozenburg et al., 1972; Clark, 1973). These species could potentially support sport fishing in the area during the months of maximum discharge, which occur in the spring (Clark, 1973).

Despite of the paucity of published accounts on recreation activities and information on recreational opportunities along the upper Navasota River, interviews of a few landowners conducted over the phone provide information on historical recreational use in the Navasota River (1210A). Please see the Recreational Use Interviews section contained in the Results of the report.

#### **Unclassified Water Body 1212B (East Yegua Creek):**

East Yegua Creek originates near Rockdale in Milam County and flows 45 miles southeast to its confluence with the Middle Yegua Creek which together form the Yegua Creek (The Handbook of Texas Online, 2011).

East Yegua Creek (1212B) is located within the USGS Hydrologic Unit 12070102: Texas-Gulf Region > Lower Brazos Subregion > Yegua. This hydrologic unit, or watershed, encompasses approximately 1,330 square miles (Seaber et al. 1994) in the North Central Texas and South Central Texas Climate Divisions (Appendix 1).

#### **Climate**

The upper portion of East Yegua Creek (1212B), from its origin to sampling site 1212B.5 is located within the North Central Texas Climate Division (i.e. division No. 3, NOAA 2005). Moisture conditions for the North Central Texas Climate Division were described above (Fig. 4, 5).

Precipitation patterns near the beginning of the stream segment show that this area receives slightly less rain in comparison to the northern portion of the division (see Fig. 26). May is the

month with the highest average rainfall (i.e. 4.6 inches) followed by another peak of rainfall in October (i.e. 3.8 inches; Fig. 33). The driest month of the year is August with an average of 2 inches of rainfall. December, January and February are also very dry with an average rainfall under 3 inches (Fig. 33). Unfortunately, the station from which this precipitation data was recorded does not record temperature.

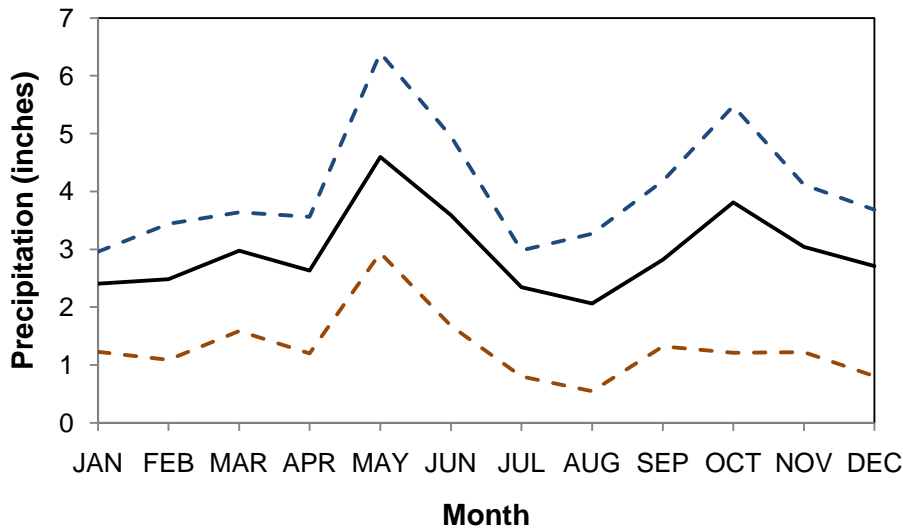


Figure 33. Monthly average 25<sup>th</sup>-percentile (lower dashed line), mean (solid line), and 75<sup>th</sup>-percentile (upper dashed line) precipitation for Thorndale City, Milam County, Texas (1970 – 2010); Data from NOAA 2011).

The lower portion of East Yegua Creek (1212B), from sampling site 1212B.6 to sampling point 1212B.26, is located within the South Central Texas Climate Division (i.e. division No. 7, NOAA 2005).

The climate of the South Central Texas region is classified as modified humid subtropical with hot summers and mild winters (Natural Fibers Information Center, 1987). Maximum temperatures over 80 °F are common from April to October and a short cool season extends from December to January with monthly minimum temperatures under 40 °F (Fig. 34). The highest average rainfall occurs between May and June (i.e. over 4.0 inches), followed by a short rainfall

peak in October (i.e. 4.3 inches; Fig. 35). January and February are the driest months of the year with an average of < 2 inches of rainfall (Fig. 35).

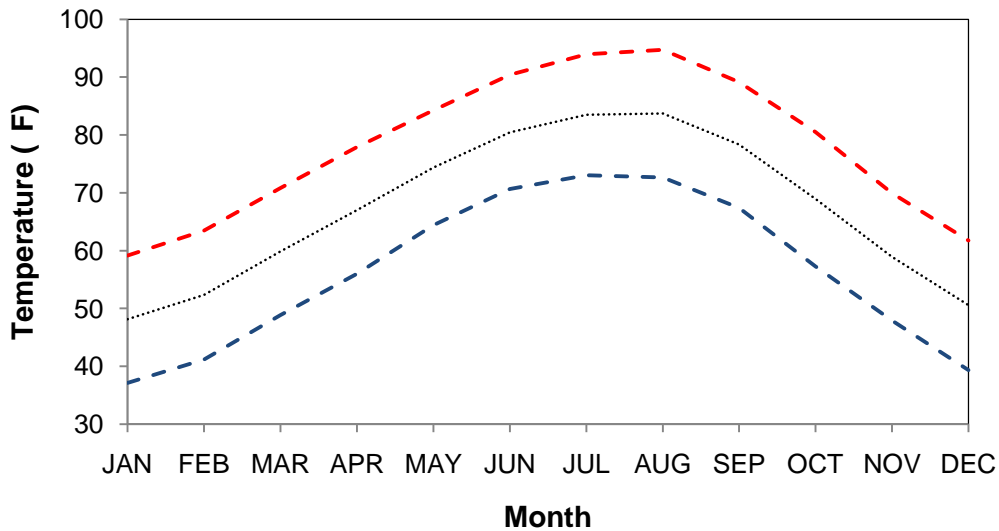


Figure 34. Monthly average normal minimum (blue dashed line), mean (dotted line) and maximum temperatures (red dashed line) for Lexington City, Lee County, Texas (Jan 1970 – Oct 2010); Data from NOAA 2011).

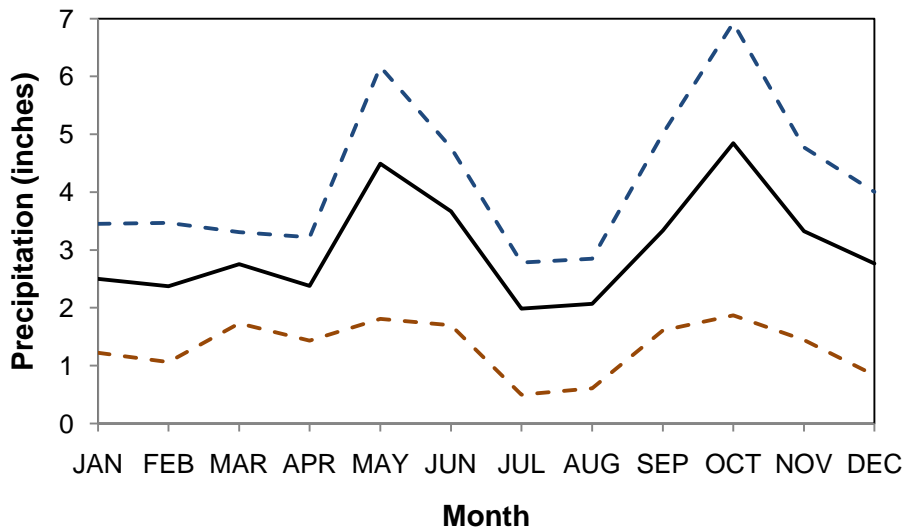


Figure 35. Monthly average 25<sup>th</sup>-percentile (lower dashed line), mean (solid line), and 75<sup>th</sup>-percentile (upper dashed line) precipitation for Lexington City, Lee County, Texas (1970 – 2010); Data from NOAA 2011).



Historically (1970—2010), monthly short-term moisture conditions have regularly fluctuated between wet and dry spells on average every 23 months ( 2.6 for wet spells and 2.7 for dry spells) with the longest short-term spells lasting 11 (wet spells) to 12 (dry spells) months (Fig. 36). The longest short-term wet spells occurred between November 1978—November 1979 and December 1991—October 1992, while the longest short-term dry spells occurred between August 2005—October 2006, September 2007—August 2008, and October 2008—March 2010.

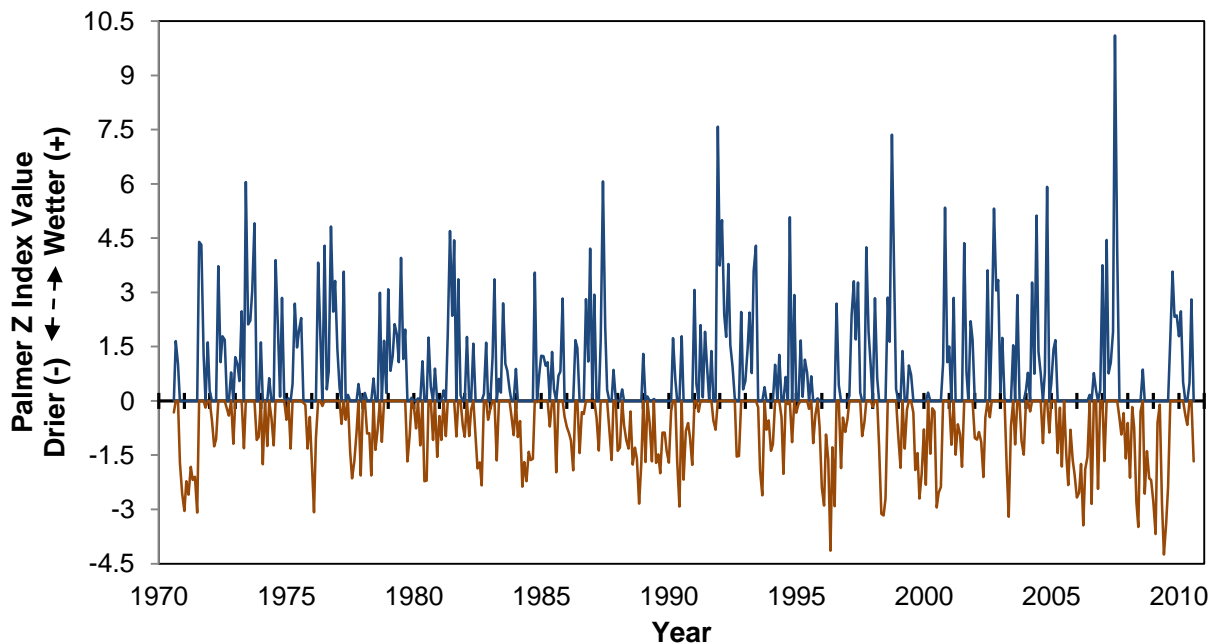


Figure 36. Short-term moisture departures from normal (Palmer Z Index) for the South Texas Climatic Division (August 1970 – August 2010; Data from NOAA 2009c).

Long-term moisture conditions showed more extreme departures from normal conditions (Fig. 37). There were a few more long-term wet than dry periods (i.e. 18 and 16, respectively), and wet periods also tended to last longer. The average duration of long-term wet periods was 17 months and ranged from 4 to 50 months. The longest long-term wet period (50 months) occurred between December 1971—February 1976. Long-term dry periods averaged 10.3

months and ranged from 1 to 35 months. The longest long-term dry period (35 months) occurred between May 1988—March 1991.

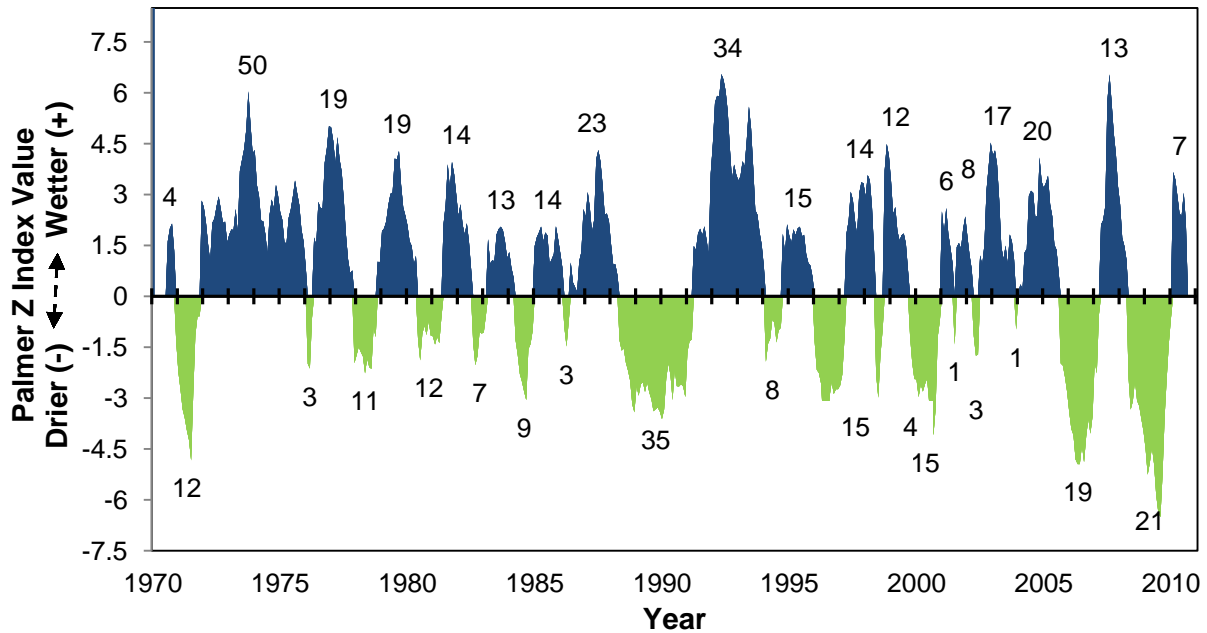


Figure 37. Long-term moisture conditions (Palmer Hydrological Drought Index Values, PHDI) and duration in months (numbers) for the South Texas Climatic Division (August 1970 – August 2010; Data from NOAA 2009c).

### Local Population

East Yegua Creek (1212B) flows through Milam County and continues south constituting the boundary between Burleson and Lee counties. General descriptions of county local populations are presented below and are based on data from the United States Census Bureau. Otherwise stated, population estimates and statistics represent averages between January 2005 and December 2009 (Census 2011).

## Milam County

This county covers 1,016.71 square miles and had an estimated population of 24,628 (23.8 persons/mi<sup>2</sup>) in 2009. The population has increased by 1.6% since 2000 and by 23% since 1970 (Fig. 38). Infants and young accounted for nearly a third of the total population in 2009 (i.e. 27.3% were under 18 years old, and 7.5% were children under 5 years old). Agriculture, forestry, fishing, hunting, and mining accounted for 7% of employment opportunities in Milam County between 2005 and 2009. These economical activities represented the fifth main source of employment after educational services, health care and social assistance activities (22%), manufacturing (14%), construction (13%), and retail trade (12%).

East Yegua Creek (1212B) extends over approximately 12.60 miles in Milam County, along agricultural fields. The largest urban area is Rockdale City with an estimated population of 5,918 in 2009. Other smaller urban areas include Cameron (5,715 residents), Thorndale (1,265 residents), Milano (538 residents), and Buckholts (359 residents). The closest urban area to East Yegua Creek in Milam County is Rockdale, located at approximately 3.85 mi away from the creek, measured by straight line.

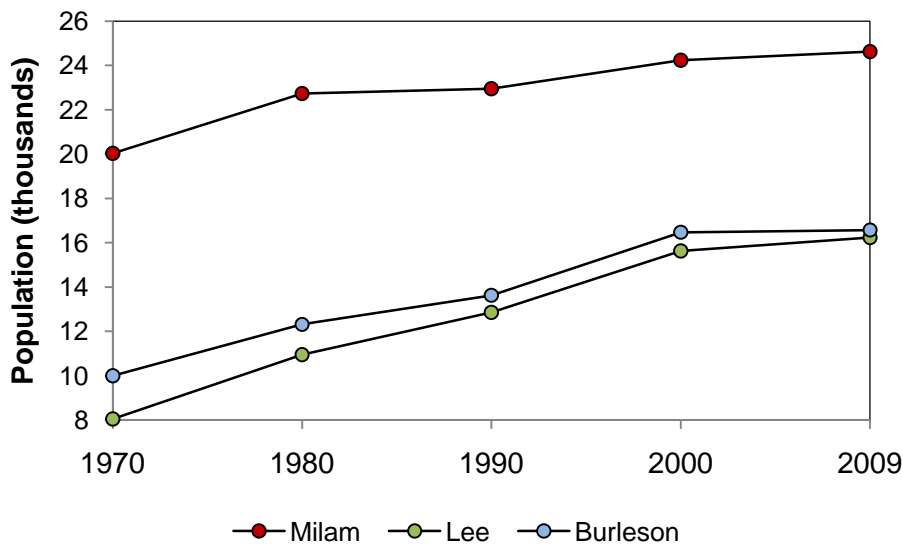


Figure 38. Decennial U.S. Census population values for counties along East Yegua Creek (1212B), Texas. (Data from Census 2011).

## **Burleson County**

This county covers 665.54 square miles and had an estimated population of 16,570 (24.7 persons/mi<sup>2</sup>) in 2009. The population has increased by 0.6% since 2000 and by 65.7% since 1970 (Fig. 58). Infants and young accounted for nearly a quarter of the total population (i.e. 23.5% was under 18 years old, and 6.9% were children under 5 years old). Agriculture, forestry, fishing, hunting, and mining along with retail trade accounted for 12% of employment opportunities in Burleson County between 2005 and 2009. These economical activities represented the second main source of employment after educational services, health care, and social assistance activities (25%).

East Yegua Creek extends over approximately 25.65 miles between Burleson and Lee Counties, along agricultural fields. The largest urban area in Burleson County is Caldwell City with an estimated population of 3,719 in 2009. Other smaller populated areas include Somerville (1,487 residents) and Snook (577 residents). Caldwell City, located 10.73 mi away by straight line from East Yegua Creek, is the closest urban area to the creek.

## **Lee County**

This county covers 628.50 square miles and had an estimated population of 16,231 (24.9 persons/mi<sup>2</sup>) in 2009. The population has increased by 3.7% since 2000, and has doubled in the last forty years (i.e. 101.7% increment since 1970, Fig. 58). Infants and young accounted for nearly a tenth of the total population in 2009 (i.e. 26% were under 18 years old, and 6.5% of these were children under 5 years old). Agriculture, forestry, fishing, hunting, and mining accounted for 9% of employment opportunities in Lee County between 2005 and 2009. These economical activities represented the fifth main source of employment after educational services, health care, and social assistance activities (17%), retail trade (14%), construction (11%), public administration (11%), and manufacturing (10%).

The largest urban area in Lee County is Giddings City with an estimated population of 5,372 in 2009. Lexington is a smaller town with 1,174 residents, located at approximately 7.42 mi away from East Yegua Creek, measured by straight line.

## Current Land Use and Changes Since 1970

Current land use data of all lands within 1 km of East Yegua Creek were obtained from the United States Geological Survey (USGS) National Land Cover Dataset (NLCD) (2006). Land uses were grouped into seven Anderson Level I land use classifier categories (Fry et al. 2009). Current (i.e., 2006) land uses for all lands within 1 km of East Yegua Creek are shown in Figure 39.

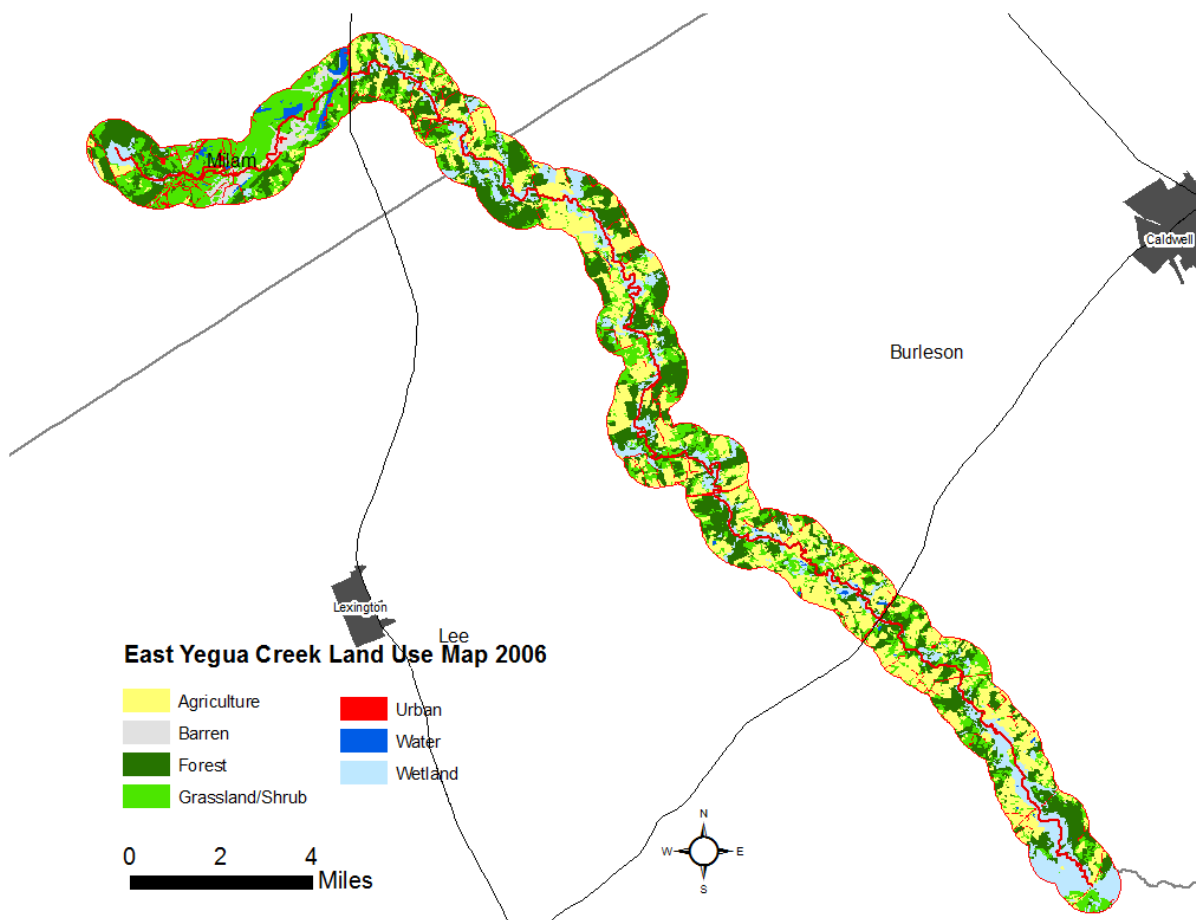


Figure 39. Land uses of East Yegua Creek based on the 2006 USGS National Land Cover Dataset.

Forest, agriculture, and grassland/shrub land use accounted for 27.5%, 23.7%, and 22%, respectively, of the total land use within 1 km of the East Yegua Creek (Figure X). Wetlands accounted for 16.4% followed by urban (3.5%), and barren (2.1%). Water covers 1.1% of the total land area.

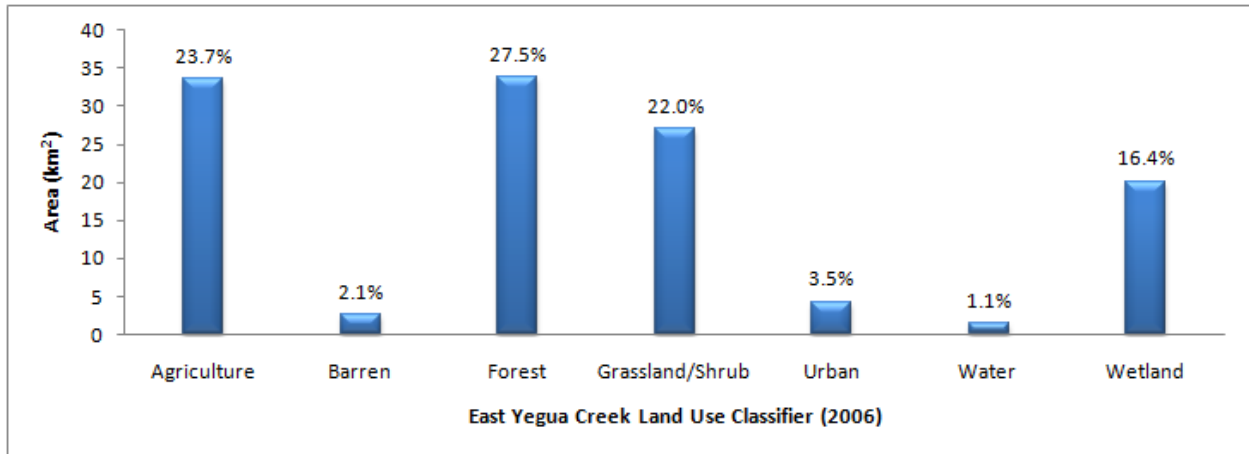


Figure 40. Total land area and percentage of the total for each land use classifier category for all lands within 1km of East Yegua Creek in 2006.

The GIRAS Land Use Land Cover Dataset (1970) was obtained from the USGS and used to characterize historic land use within a 1 km of East Yegua Creek (Figure 41). ESRI ArcMap's Spatial Analyst was used to quantify the changes in land use from the 1970 to 2006. Figure 42 shows all the lands adjacent to East Yegua Creek that have changed in their land use classifier category from 1970 to 2006.

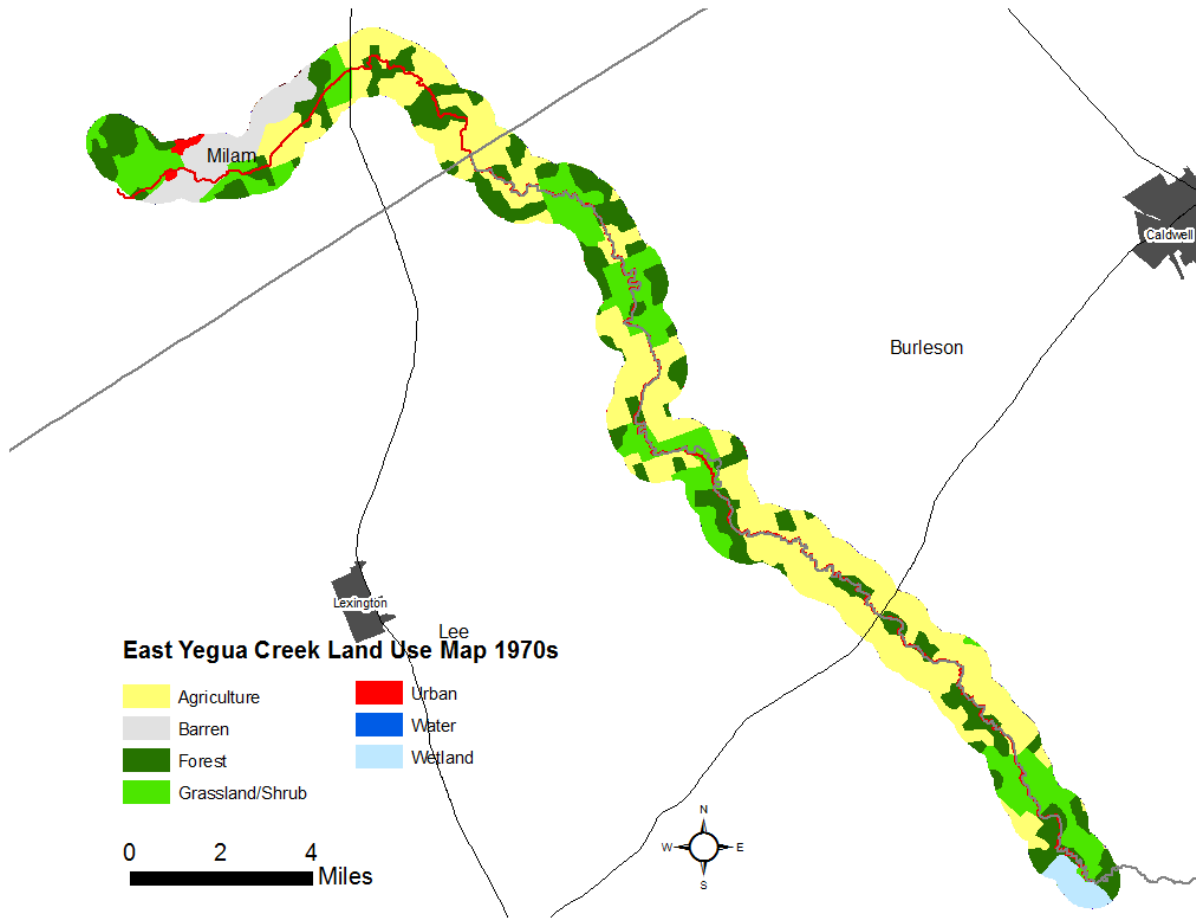


Figure 41. Land uses of East Yegua Creek based on the 1970 GIRAS Land Use Land Cover Dataset.

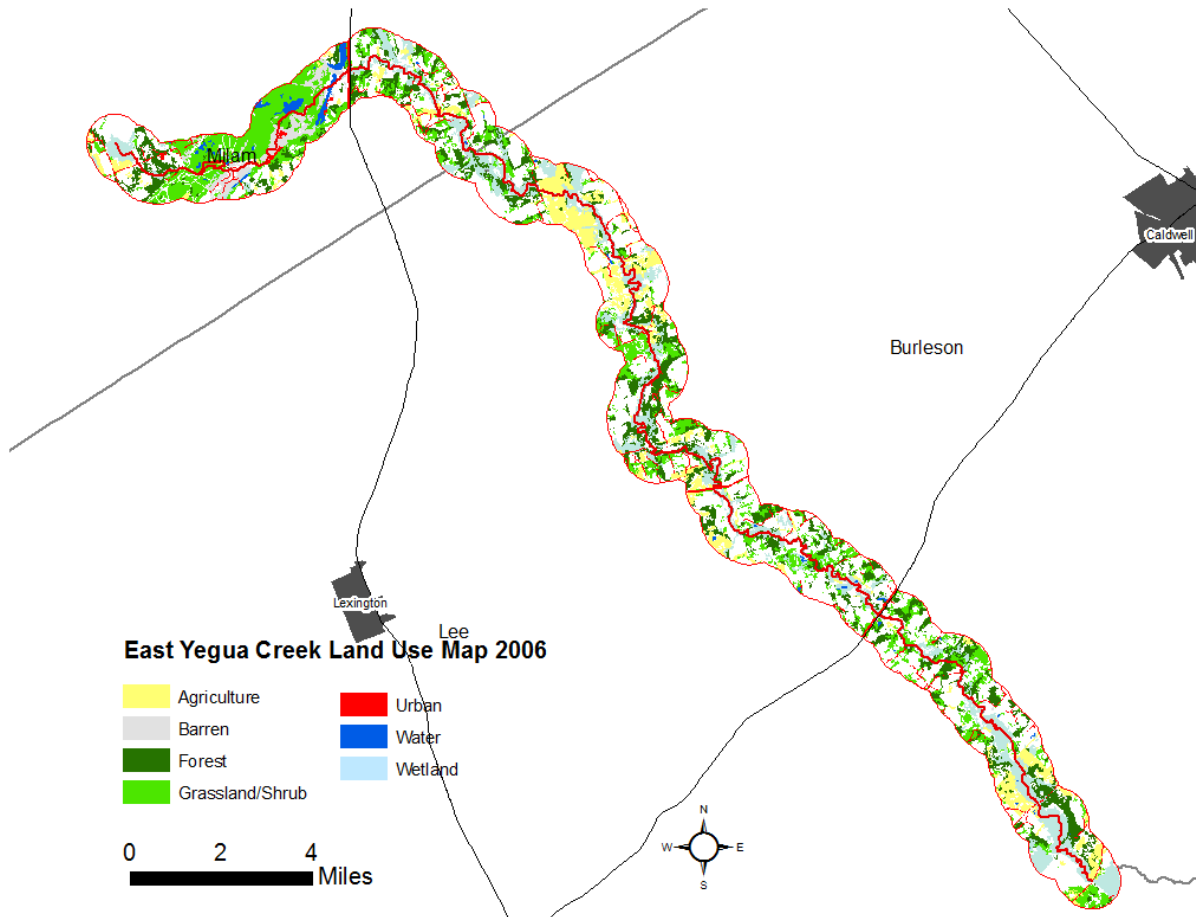


Figure 42. Map of all lands adjacent to East Yegua Creek that have changed in their land use classifier category from 1970 to 2006. Changes based on the 1970 GIRAS Land Use Land Cover Dataset and the 2006 USGS National Land Cover Dataset.

From 1970 to 2006, agriculture decreased by 17.1% followed by barrens (3.9%) (Figure 43). Wetlands increased overall by 14.6%. Urban areas, forests, and water increased in area by 3.0 %, 2.1%, and 1.1%, respectively.



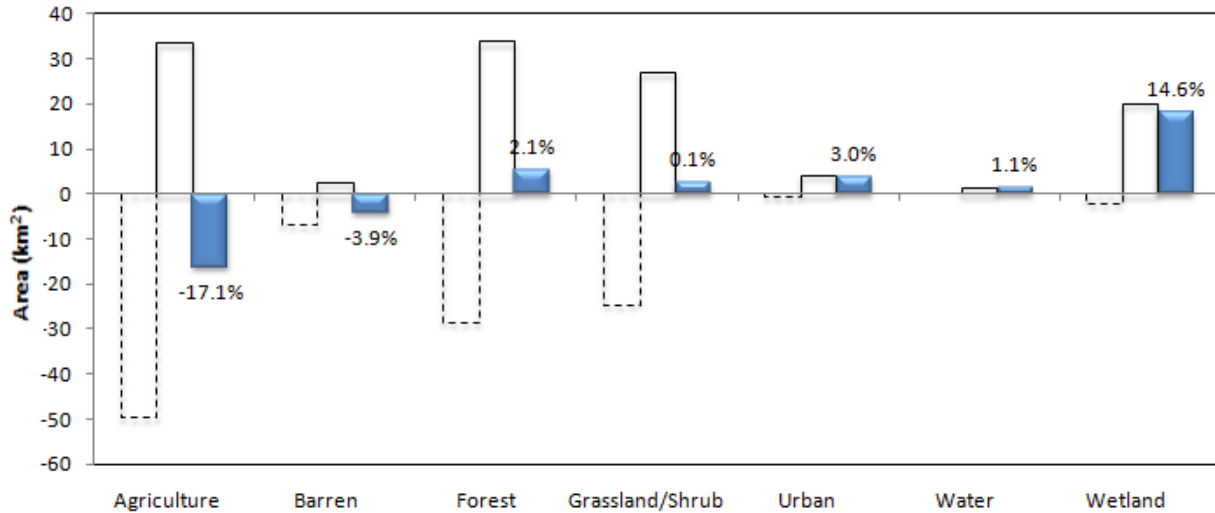


Figure 43. Changes in land use area (gross losses=dashed bars, gross gains=solid white bars, net change=colored bars with percentages) for East Yegua Creek from 1970 to 2006.

### Historical Accounts of Recreation

Accounts of historical recreation along the Yegua Creek in the literature are limited and we were unable to find any accounts of recreation that were specific to East Yegua Creek (1212B) (see Appendix 6 for a list of the references consulted).

Tourist attractions along the segment include a historical bridge located on CR424. The current bridge replaced a lost pony truss bridge built in 1906 that is listed in the web site Bridge Hunters: Historical Bridges of the United States (<http://bridgehunter.com/tx/lee/141440AA0069003/>).

Despite of the lack of published accounts on recreation activities and information on recreational opportunities along East Yegua Creek, interviews of 10 landowners conducted over the phone provide valuable information on historical recreational use in East Yegua Creek (1212B). Please see the Recreational Use Interviews section contained in the Results of the report.

### **Classified Stream Segment 1902 (Lower Cibolo Creek):**

The Cibolo Creek derives its name from the Spanish name “Arroyo del Cibolo” (Buffalo Stream). The Cibolo Creek originates in the southwest of Kendall County and flows 100 miles southeast to its confluence with the San Antonio River (Handbook of Texas Online, 2011).

The Lower Cibolo Creek (1902) is located within the USGS Hydrologic Unit 12100304: Texas-Gulf Region > Central Texas Coastal Subregion > San Antonio River Basin > Cibolo. This hydrologic unit, or watershed, encompasses approximately 861 square miles (Seaber et al. 1994) in South Texas (Appendix 1).

### **Climate**

The Lower Cibolo Creek (1902) is located within the South Texas Climate Division (i.e. division No. 7, NOAA 2005). Moisture conditions for the South Texas Climate Division were described above (Fig. 36, 37).

Precipitation patterns near the beginning of the stream segment have data similar to the northern portion of the division (see Fig. 35). Maximum temperatures over 80 °F are common from April to October (Fig. 19). The highest average rainfall occurs between May and June (i.e. over 4.0 inches); followed by another rainfall peak in October (i.e. 4.2 inches; Fig. 20). The cool season extends from December to January with monthly minimum temperatures under 40 °F (Fig. 44). December to February are the driest months of the year with < 2.5 inches average rainfall (Fig. 45).

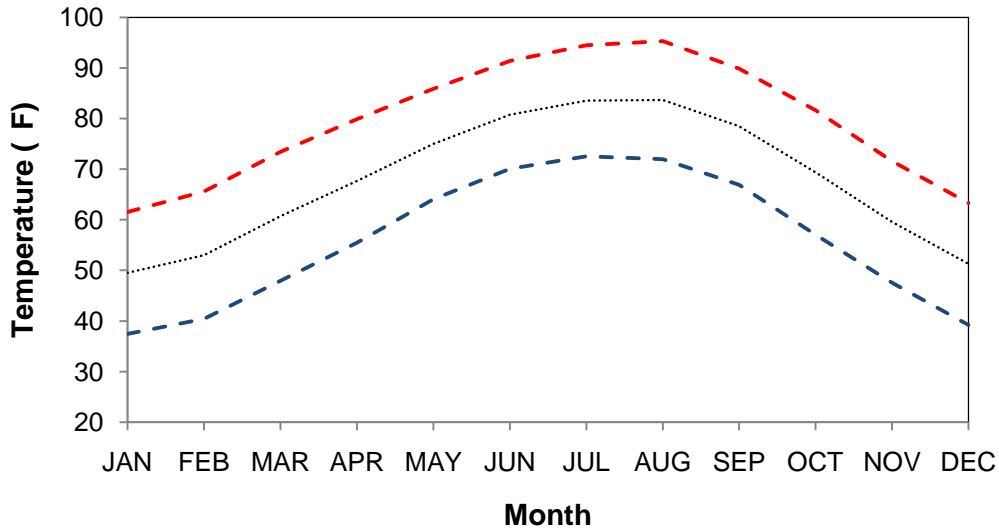


Figure 44. Monthly average normal minimum (blue dashed line), mean (dotted line) and maximum temperatures (red dashed line) for New Braunfels, Comal County, Texas (Jan 1970 – Oct 2010); Data from NOAA 2011).

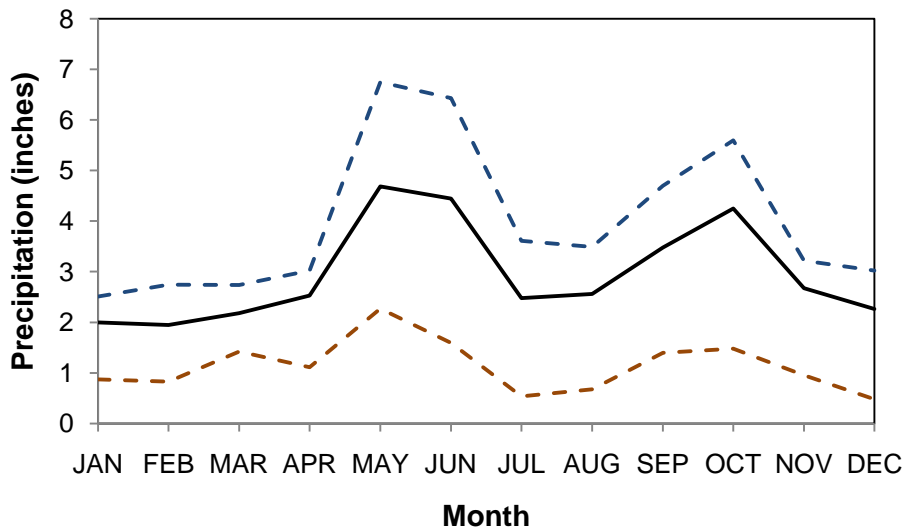


Figure 45. Monthly average 25<sup>th</sup>-percentile (lower dashed line), mean (solid line), and 75<sup>th</sup>-percentile (upper dashed line) precipitation for New Braunfels City, Milam County, Texas (1970 – 2010); Data from NOAA 2011).

The upper portion of the Lower Cibolo Creek partially delineates the boundary between Bexar and Guadalupe counties. The creek continues its flow to the south through Wilson and Karnes

counties. General descriptions of county local populations are presented below and are based on data from the United States Census Bureau. Otherwise stated, population estimates and statistics represent averages between January 2005 and December 2009 (Census 2011).

### **Bexar County**

This county covers 1,246.82 square miles and had an estimated population of 1,651,448 (1,117 persons/mi<sup>2</sup>) in 2009. The population has increased by 18.6% since 2000 and has almost doubled in the last forty years (i.e. 98.9% increment since 1970, Fig. 46). Infants and young accounted for nearly a third of the total population in 2009 (i.e. 28% were under 18 years old, and 8.4% were children under 5 years old). Agriculture, forestry, fishing, hunting, and mining accounted for only 1% of employment opportunities in Bexar County, between 2005 and 2009. These economical activities represented the ninth and last largest source of employment in the county. The first three major economical activities were educational services, health care, and social assistance activities (22%), retail trade (12%), and professional, scientific and management, administrative and waste management services (11%).

The Lower Cibolo Creek extends for approximately 22 miles along the eastern limit of Bexar County, along agricultural fields and sparsely populated semi-urban areas. The largest urban area is San Antonio City with an estimated population of 1,296,682 in 2006. Other smaller urban areas include Schertz (28,428 residents), Universal City (17,437 residents), Timberwood Park (6,991 residents), Selma (2,997 residents), and St. Hedwig (1,707 residents). Schertz is the closest urban area to the Lower Cibolo Creek, located at approximately 1.57 mi away by straight line.

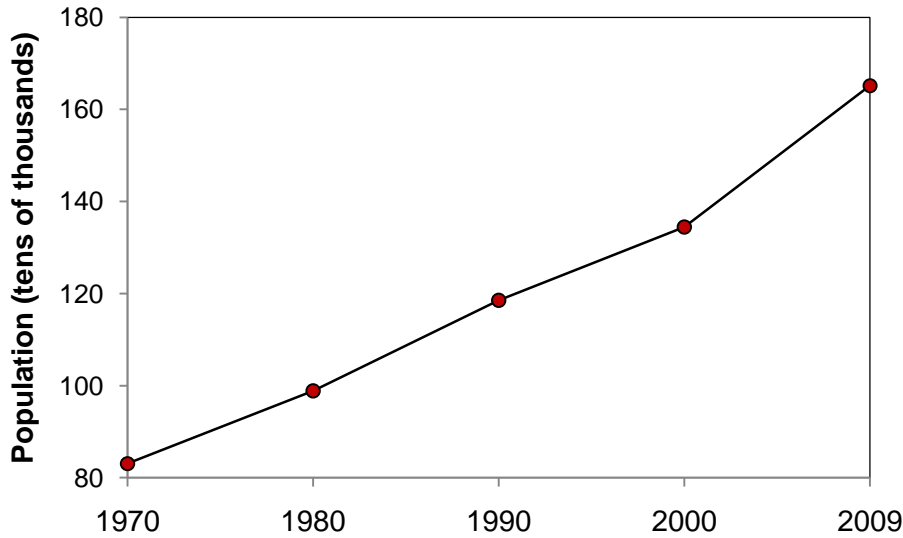


Figure 46. Decennial U.S. Census population values for Bexar County, Lower Cibolo Creek (Stream Segment 1902), Texas. (Data from Census 2011).

### Guadalupe County

This county covers 711.14 square miles and had an estimated population of 121,432 (125.2 persons/mi<sup>2</sup>) in 2009. The population has increased by 36.4% since 2000 and has almost quadrupled in the last forty years (i.e. 261.9% increment since 1970, Fig. 47). Infants and young accounted for over a quarter of the total population in 2009 (i.e. 26.5% were under 18 years old, and 7% were children under 5 years old). Agriculture, forestry, fishing, hunting, and mining accounted for only 2% of employment opportunities in Guadalupe County, between 2005 and 2009. These economical activities represented the ninth largest source of employment in the county. The first three major economical activities were educational services, health care, and social assistance activities (20%), retail trade (13%), and manufacturing (12%).

The Lower Cibolo Creek extends for approximately 29 miles along the Western limit of Guadalupe County, along agricultural fields and sparsely populated areas. The San Antonio Metropolitan area extends over the county. The largest urban area is Seguin with an estimated population of 25,875. Other smaller urban areas include Cibolo (11,937 residents), McQueeney (2,026 residents), Marion (886 residents), and New Berlin (491 residents). The creek passes by the western portion of the city of Cibolo.

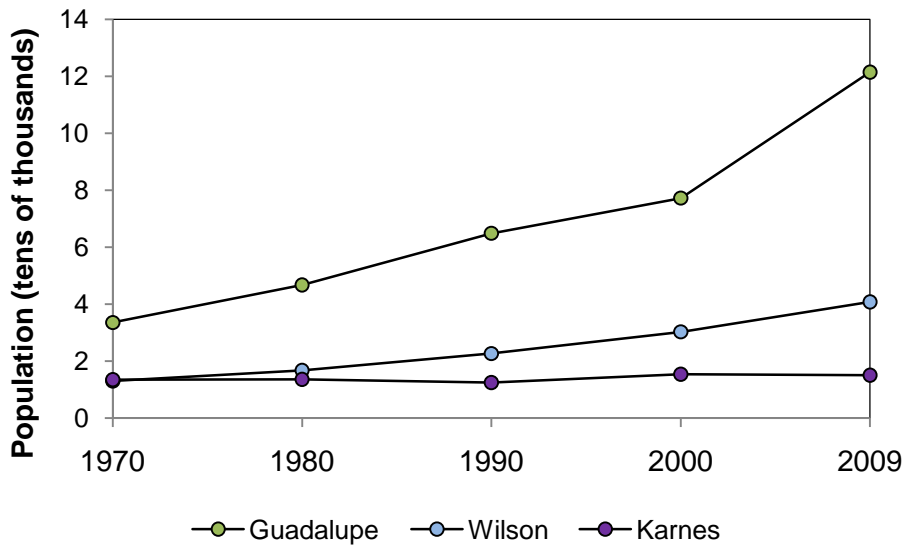


Figure 47. Decennial U.S. Census population values for counties along the Lower Cibolo Creek (1902), Texas. (Data from Census 2011).

### Wilson County

This county covers 806.99 square miles and had an estimated population of 40,749 (40.2 persons/mi<sup>2</sup>) in 2009. The population has increased by 25.7% since 2000 and has more than tripled in the last forty years (i.e. 212.47% increment since 1970, Fig. 47). Infants and young accounted for over a quarter of the total population in 2009 (i.e. 26% were under 18 years old, and 6.5% were children under 5 years old). Agriculture, forestry, fishing, hunting, and mining accounted for only 4% of employment opportunities in Guadalupe County, between 2005 and 2009. These economical activities, along with whole sale trade and other services except for public administration, represented the ninth largest source of employment in the county. The first three major economical activities were educational services, health care and social assistance activities (22%), retail trade (11%), and construction (10%).

The Lower Cibolo Creek extends for approximately 39.9 miles through Wilson County, along agricultural fields and sparsely populated areas. The San Antonio Metropolitan area extends over the county. The largest urban area is Floresville with an estimated population of 7,302.

Other smaller urban areas include Stockdale (1,578 residents), La Vernia (1,418 residents), and Wilson (588 residents). The creek passes by the eastern portion of the city of La Vernia.

## **Karnes County**

This county covers 750.32 square miles and had an estimated population of 15,029 (20.6 persons/mi<sup>2</sup>) in 2009. The population has decreased by 2.7% since 2000 but it has increased by 11.6% since 1970 (Fig. 47). Infants and young accounted for under a quarter of the total population in 2009 (i.e. 20.6% was under 18 years old, and 6.1% were children under 5 years old). Agriculture, forestry, fishing, hunting, and mining accounted for 9% of employment opportunities in Karnes County between 2005 and 2009. These economical activities represented the fourth main source of employment after educational services, health care and social assistance activities (22%), public administration (12%), and retail trade (11%).

The Lower Cibolo Creek extends for approximately 15.4 miles through Karnes County, along agricultural fields. The largest urban area is Karnes City with an estimated population of 4,308. Other smaller urban areas include Kennedy (2,354 residents), Runge (958 residents), and Falls City (601 residents). Falls City is the closest populated area to the Lower Cibolo Creek, located at approximately 4.9 mi away by straight line.

## **Current Land Use and Changes Since 1970**

Current land use data of all lands within 1 km of the Lower Cibolo Creek were obtained from the United States Geological Survey (USGS) National Land Cover Dataset (NLCD) (2006). Land uses were grouped into seven Anderson Level I land use classifier categories (Fry et al. 2009). Current (i.e., 2006) land uses for all lands within 1 km of the Lower Cibolo Creek are shown in Figures 48, 49, and 50.

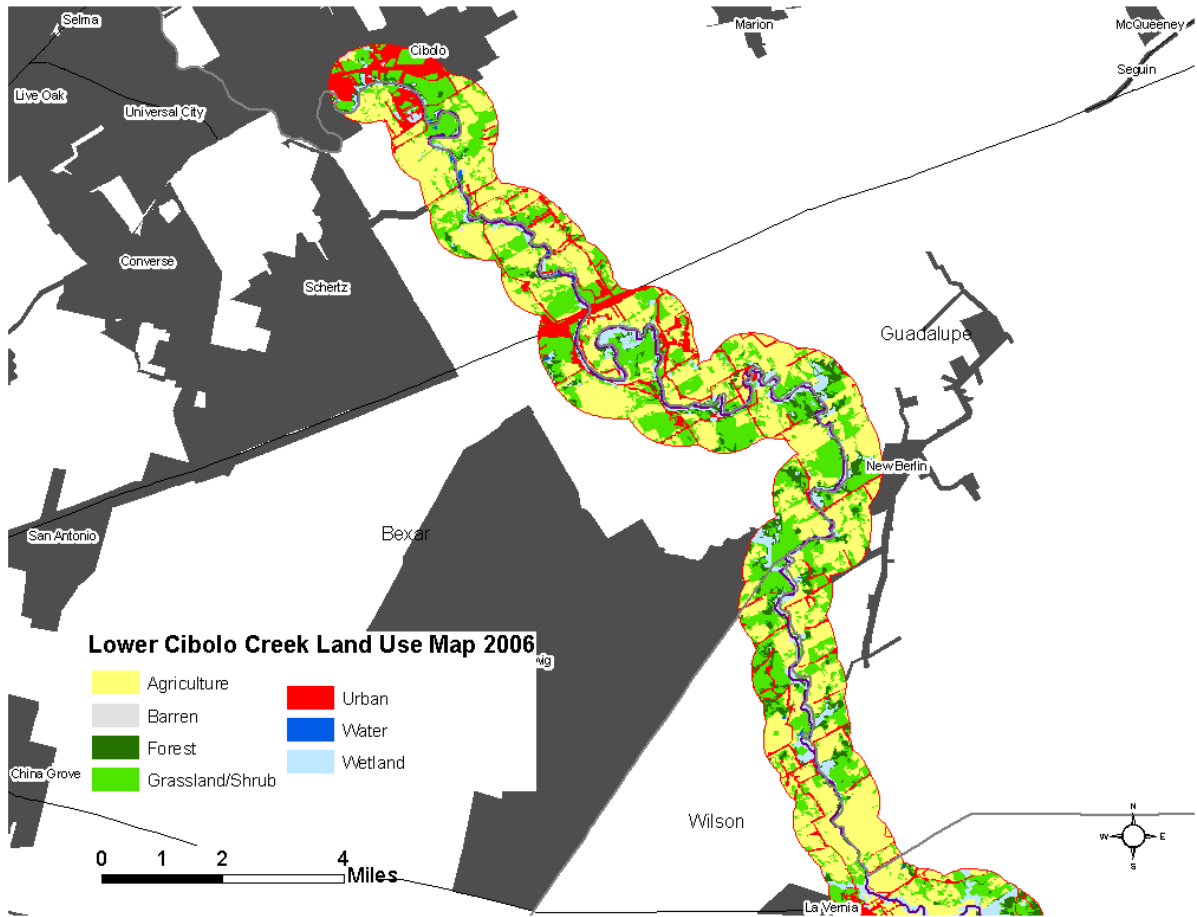


Figure 48. Land uses of the Lower Cibolo Creek based on the 2006 USGS National Land Cover Dataset (1 of 3).



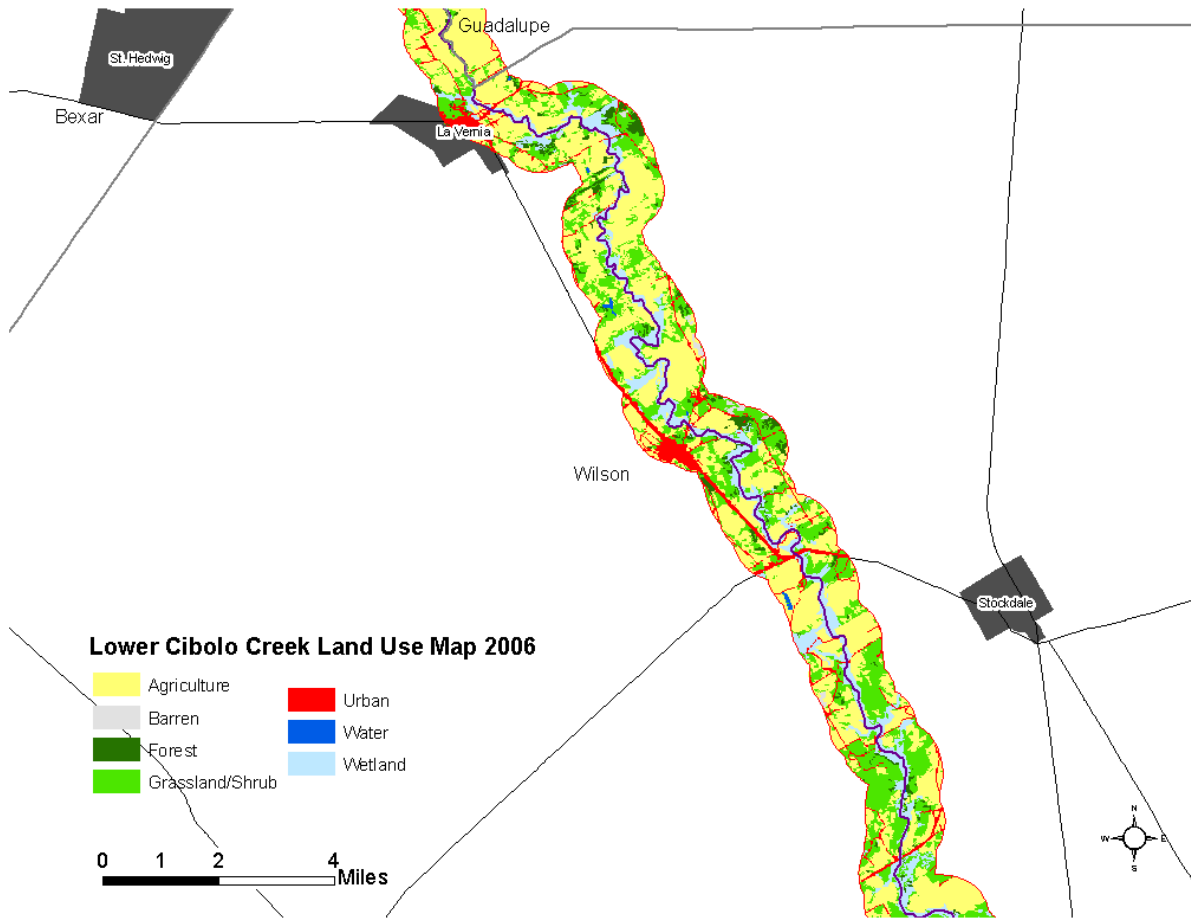


Figure 49. Land uses of the Lower Cibolo Creek based on the 2006 USGS National Land Cover Dataset (2 of 3).

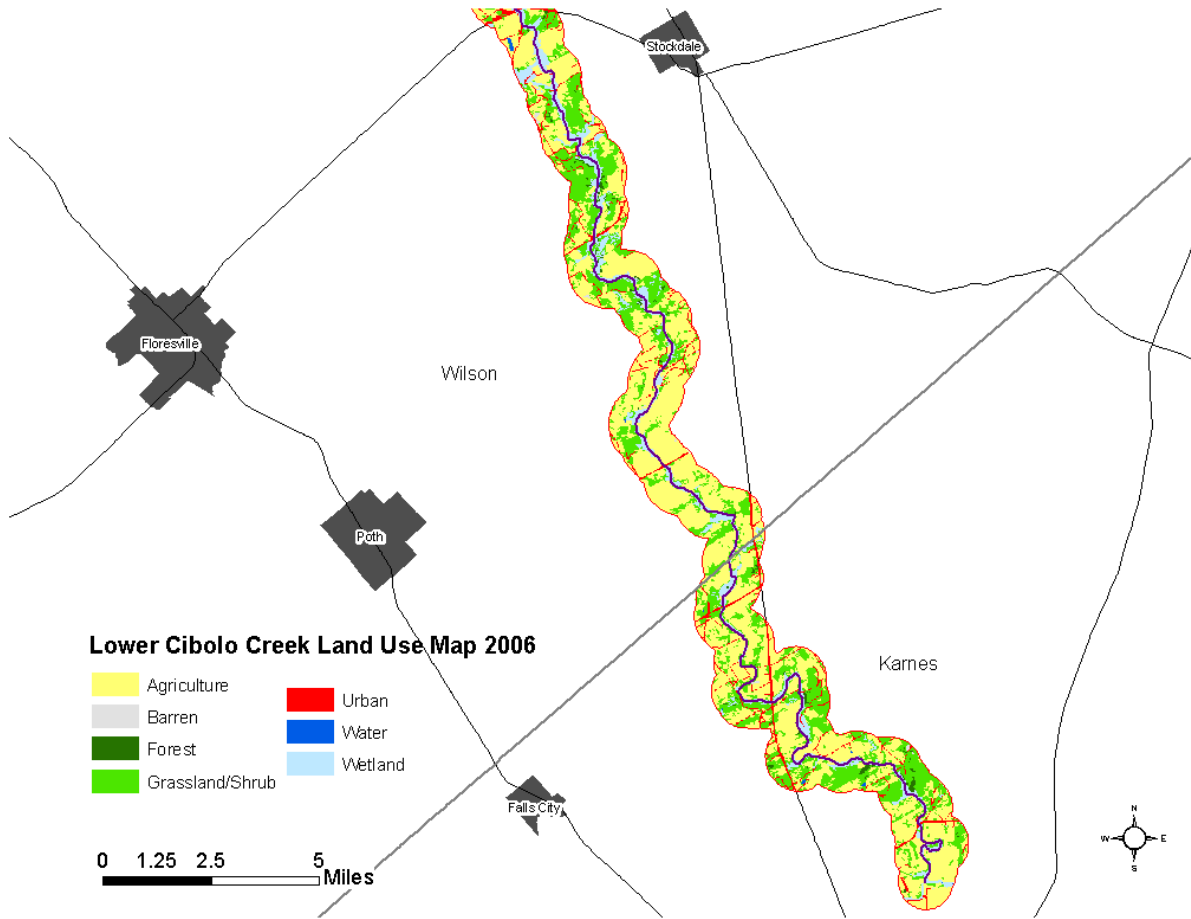


Figure 50. Land uses of the Lower Cibolo Creek based on the 2006 USGS National Land Cover Dataset (3 of 3).

Agriculture and grassland/shrub land accounted for 49.0% and 28.3%, respectively, of the total land use within 1 km of the Lower Cibolo Creek (Figure 51). Wetlands accounted for 10.9%, followed by urban (7.6%), and forest (3.6%). Barrens covers 0.3% followed by water (0.2%).

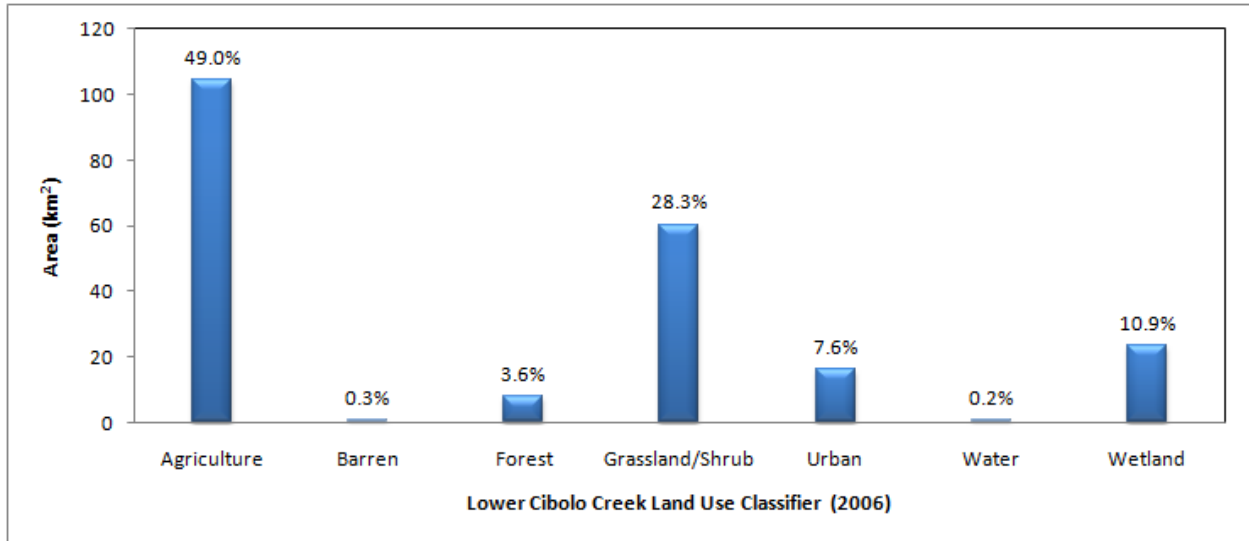


Figure 51. 2006 Total land area and percentage of the total for each land use classifier category for all lands within 1km of the Lower Cibolo Creek.

The GIRAS Land Use Land Cover Dataset (1970) was obtained from the USGS and used to characterize historic land use within a 1 km of the Lower Cibolo Creek (Figure 52-54). ESRI ArcMap’s Spatial Analyst was used to quantify the changes in land use from the 1970 to 2006. Figures 55 to 57 show all the lands adjacent to the Lower Cibolo Creek that have changed in their land use classifier category from 1970 to 2006.

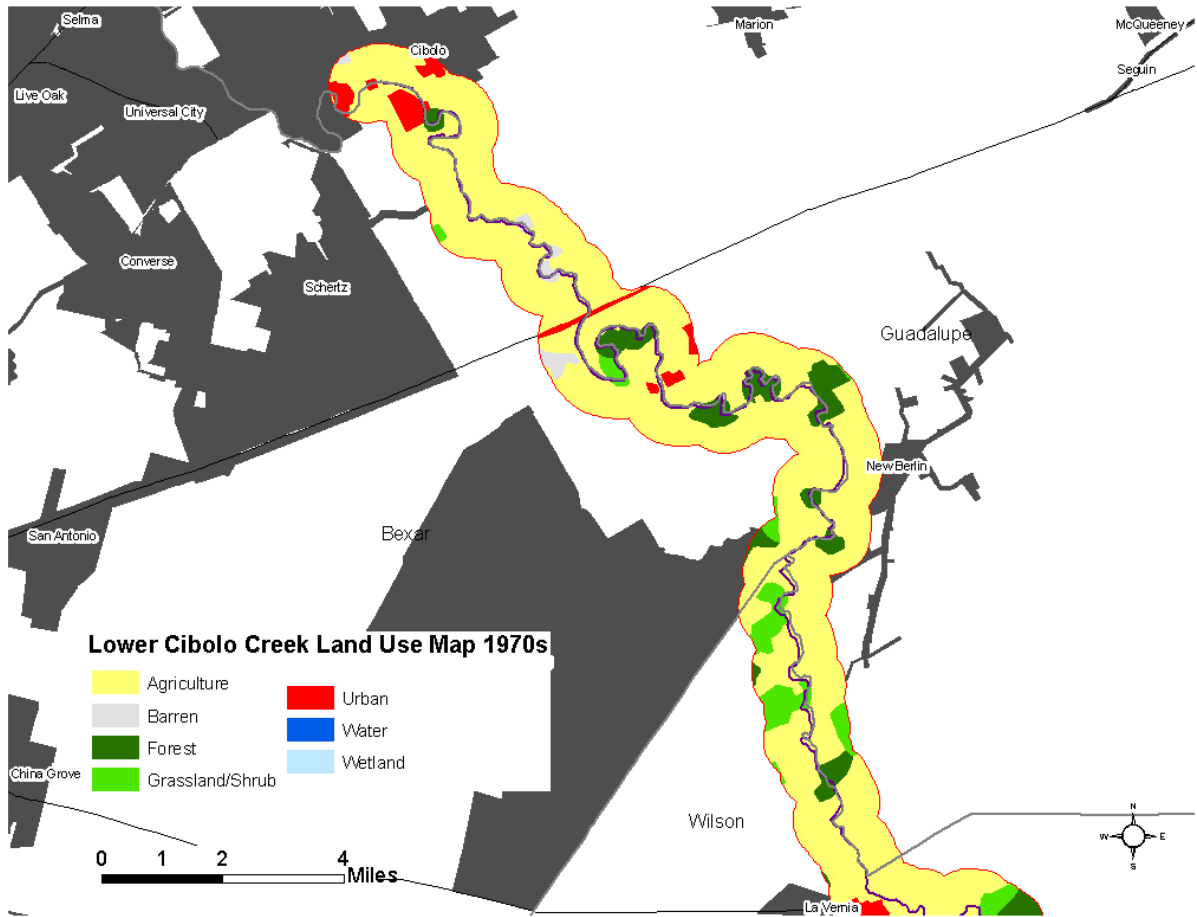


Figure 52. Land uses of the Lower Cibolo Creek based on the 1970 GIRAS Land Use Land Cover Dataset (1 of 3).

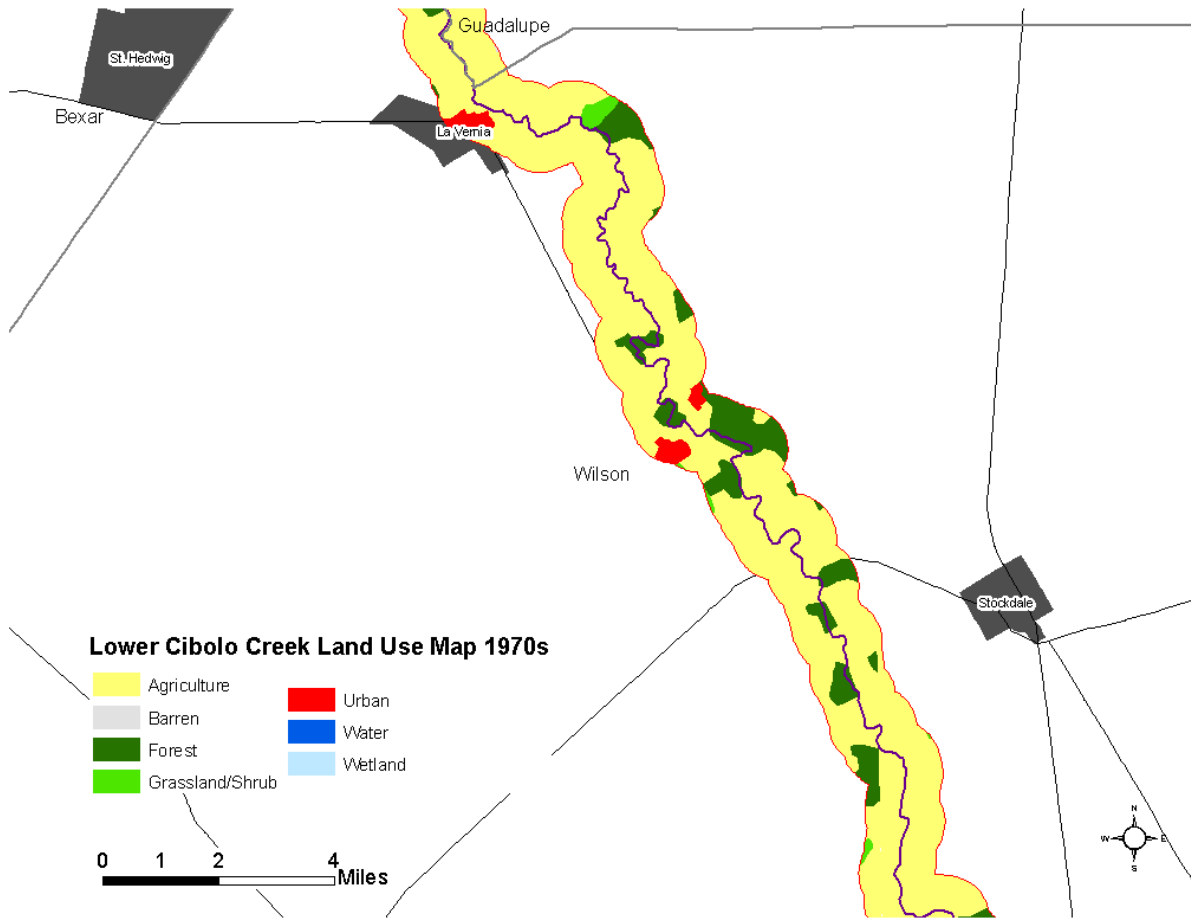


Figure 53. Land uses of the Lower Cibolo Creek based on the 1970 GIRAS Land Use Land Cover Dataset (2 of 3).

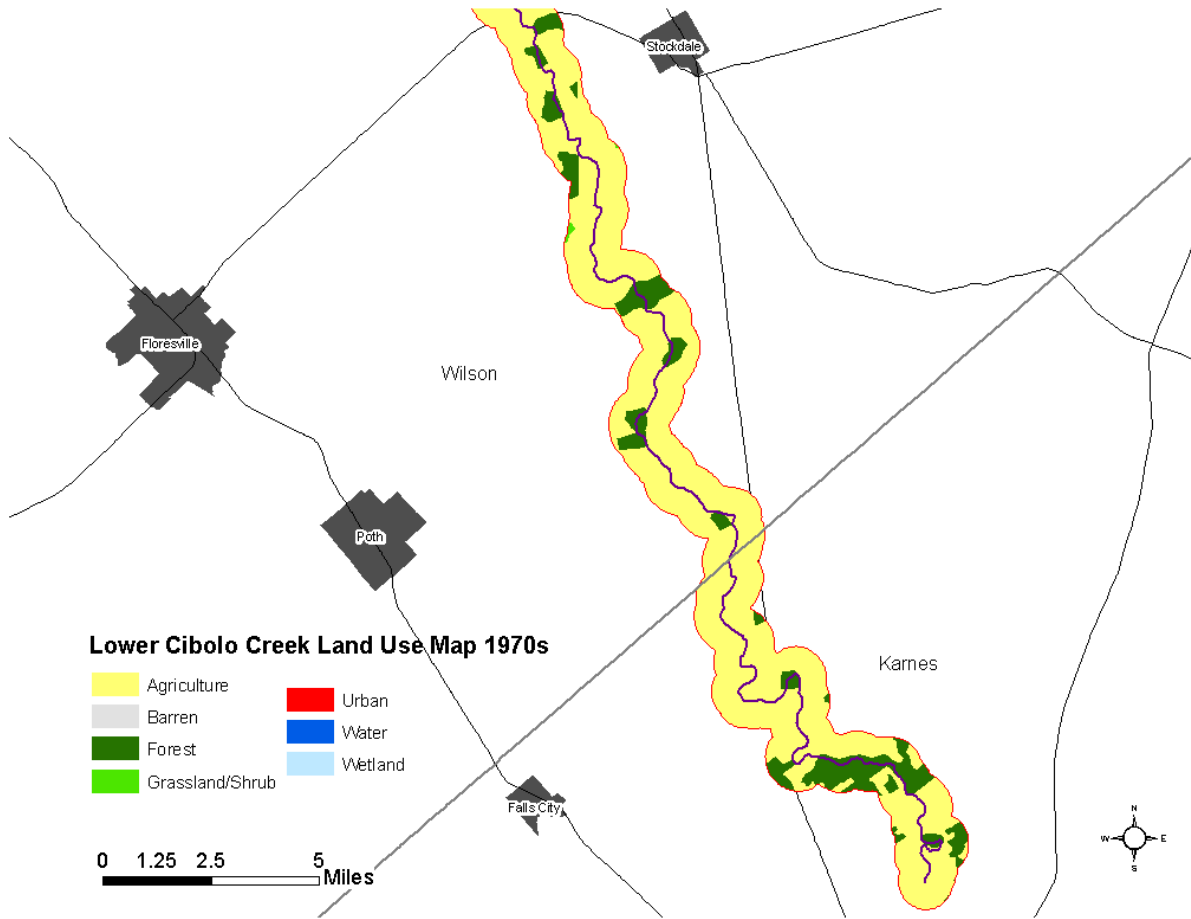


Figure 54. Land uses of the Lower Cibolo Creek based on the 1970 GIRAS Land Use Land Cover Dataset (3 of 3).

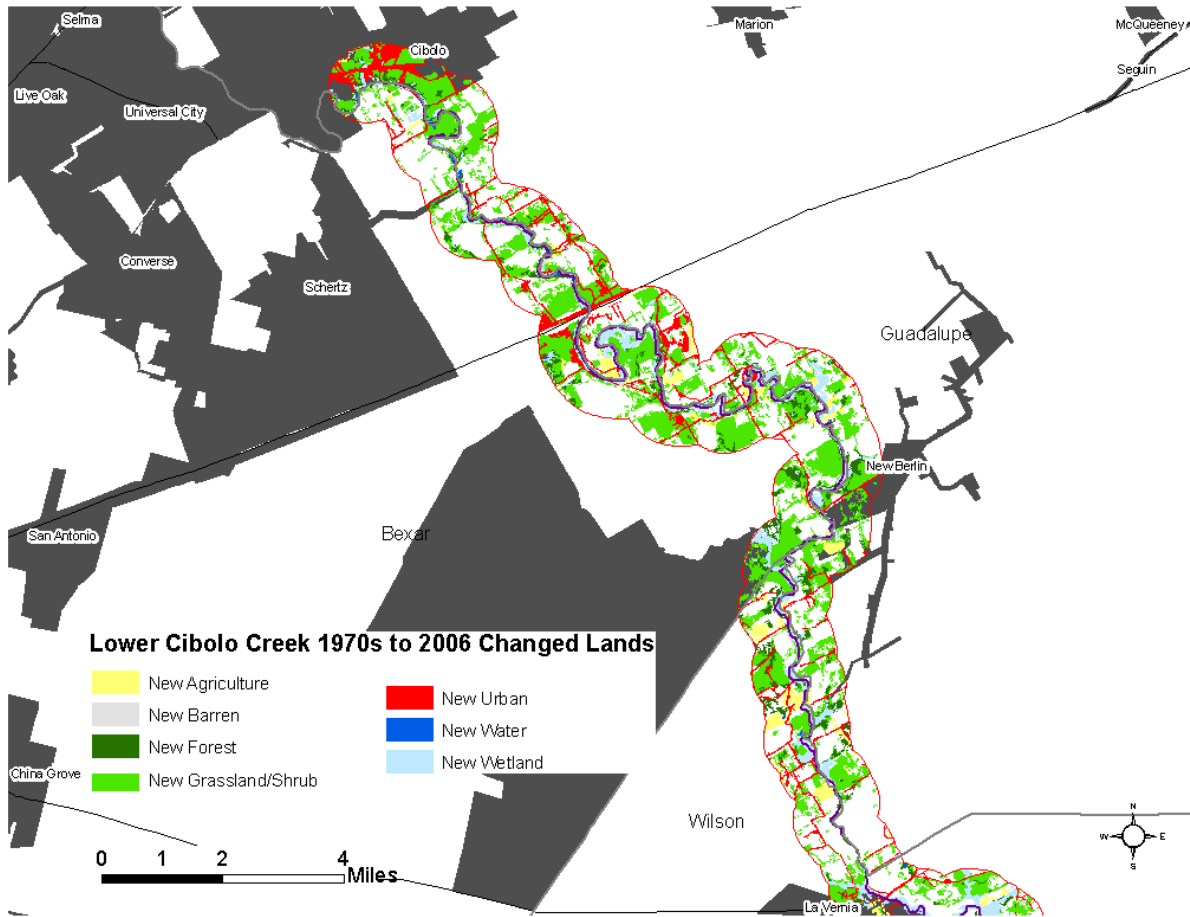


Figure 55. Map of all lands adjacent to the Lower Cibolo Creek that have changed in their land use classifier category from 1970 to 2006. Changes based on the 1970 GIRAS Land Use Land Cover Dataset and the 2006 USGS National Land Cover Dataset (1 of 3).

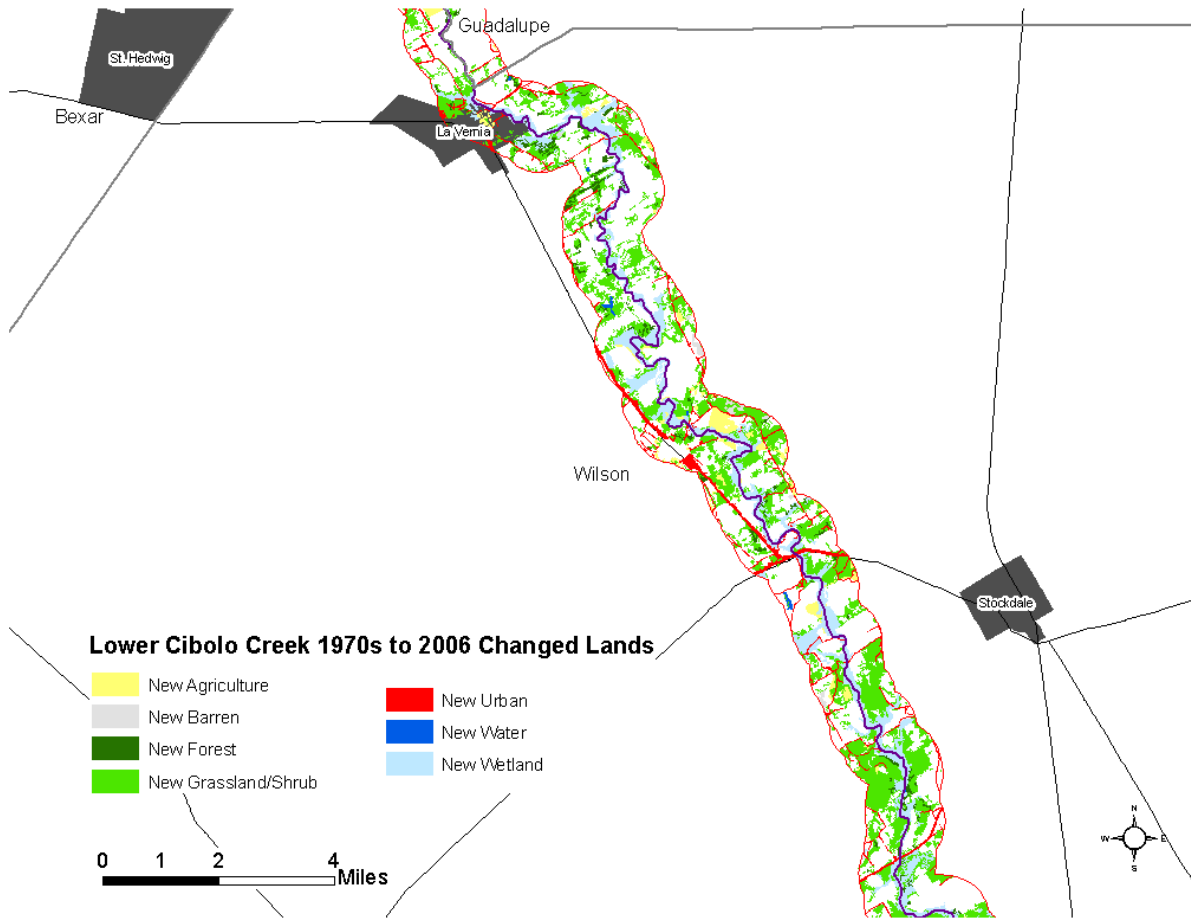


Figure 56. Map of all lands adjacent to the Lower Cibolo Creek that have changed in their land use classifier category from 1970 to 2006. Changes based on the 1970 GIRAS Land Use Land Cover Dataset and the 2006 USGS National Land Cover Dataset (2 of 3).



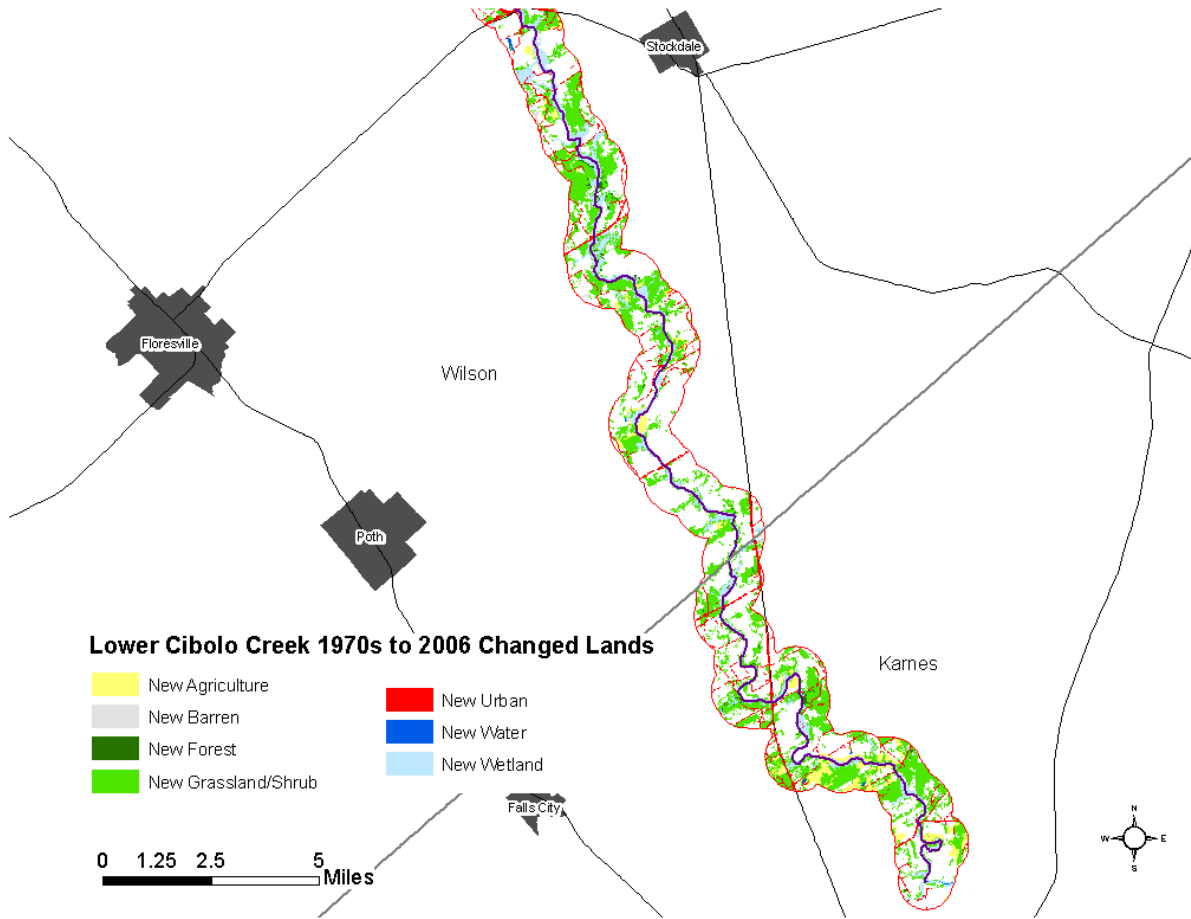


Figure 57. Map of all lands adjacent to the Lower Cibolo Creek that have changed in their land use classifier category from 1970 to 2006. Changes based on the 1970 GIRAS Land Use Land Cover Dataset and the 2006 USGS National Land Cover Dataset (3 of 3).

From 1970 to 2006, agriculture decreased by 34.9% followed by forest (8.1%) and barrens (0.2%) (Figure 58). Grassland/shrub areas, wetlands, and increased overall by 14.6%. Urban areas, forests, and water increased in area by 26.3 %, 2.1%, and 1.1%, respectively.

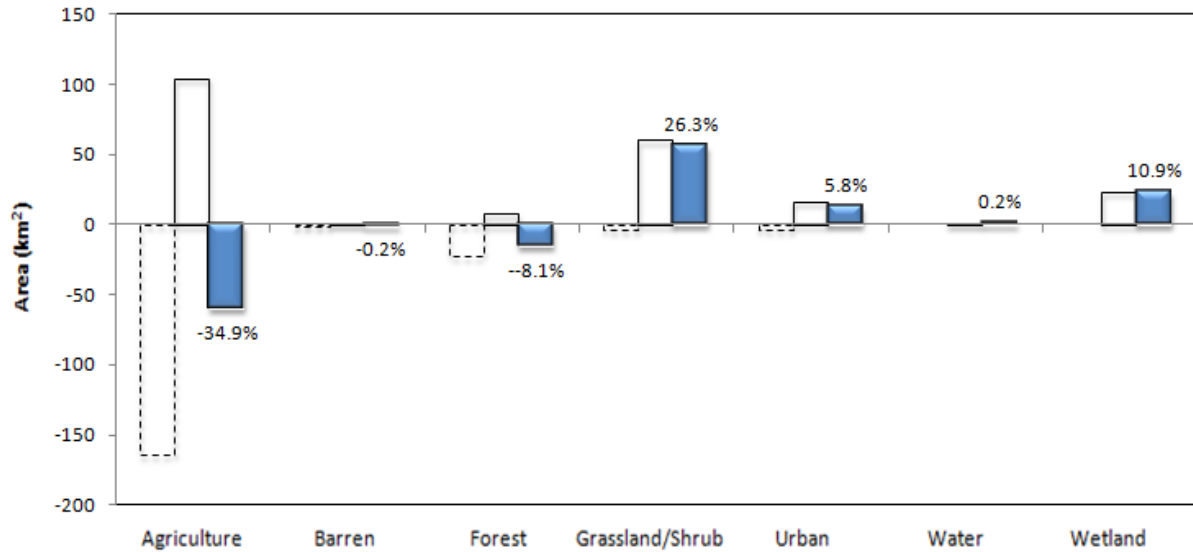


Figure 58. Changes in land use area (gross losses=dashed bars, gross gains=solid white bars, net change=colored bars with percentages) for the Lower Cibolo Creek from 1970 to 2006.

### Historical Accounts of Recreation

Accounts of historical recreation along the Lower Cibolo Creek in the literature are limited. The area surrounding the creek, however, has been historically populated since pre-European settlement. Records of native Americans in the area date back to the 1600's when native Americans of the Tonkawan linguistic family inhabited the area near the upper portion of the stream segment, in the vicinity of what is today Seguin (Guadalupe County), naming the creek "Bata Coniquiyoqui". The area surrounding the lower part of the stream segment was inhabited by native Americans of the Coahuiltecan linguistic family which referred to the creek as "Xoloton" (Martin, 1947).

Belisle and Josselet (1974) describe the Cibolo Creek as a "scenic picturesque stream" that can support recreation after periods of extended rainy weather. Similarly Kirkley (1983) discusses that even though the Cibolo Creek is one of the longest streams in the area, its average lower flow does not support recreational use all year around but only after periods of intense rainfall.

An annual end of the year picnic at the Lower Cibolo Creek has been held by the Lower Valley School, in Guadalupe County for many years. Two photographs of one of such picnics, dating back to 1950, can be seen at the Portal to Texas History ([http://texashistory.unt.edu/ark:/67531/metaph65155/?q=lower cibolo creek](http://texashistory.unt.edu/ark:/67531/metaph65155/?q=lower+cibolo+creek)).

Despite of the paucity of published accounts on recreation activities and information in recreational opportunities along the Lower Cibolo Creek, interviews to over 30 landowners and local residents conducted in the field, during the RUAA surveys, and over the phone provide a good account of historical recreational use in the Lower Cibolo Creek (1902). Please see the Recreational Use Interviews section contained in the Results of the report.

## **Methods**

### **Creation of a GIS Project**

An ESRI ArcMap GIS project was created to acquire the information needed to carry out the RUAA site surveys. Stream shapefiles were obtained from TCEQ. Shapefiles of Texas counties, cities, major roads, and stream point sources (tx\_wastewtr outfall) were obtained from TCEQs Atlas of Texas Surface Waters. A watershed shapefile (basinspy) was obtained from Texas Parks and Wildlife. Aerial photographs (2004 NAIP 1m) and street shapefiles were obtained from the Texas Natural Resources Information System. Shapefiles (polygons) of private property parcels were obtained from county property appraiser offices. A shapefile (Park Lands Combined) containing all known recreation areas in the study area was created.

### **Photograph Naming Convention**

In sequence, photograph names (i.e. 1242D.1.30\_25Up\_08032009\_23207) provide the segment identification code for the specific survey site, the location in meters along the stream reach where the photograph was taken, a photo number assigned by the camera, a code which describes the contents, the date, and the time of day to the nearest second. Photographs taken at locations other than 30, 150, or 300 meters along the reach do not have reach location(distance along the reach) information. The example photograph name above was an upstream photograph, 30 meters along the reach at survey site 1242D.1 with a camera photo number of 25. This example photograph was taken on August 3, 2009 at 2:32 pm and 7 seconds. Content codes include Up (up stream), Dwn (down stream), LB (left bank), RB (right bank), SPA (site/public access), SC (surrounding conditions), CO (channel obstructions), HM (hydrologic modifications), PR (promote recreation), IR (impede recreation), UC (unsafe condition), HP (human presence), IHU (indications of human use), G (garbage), Dam (on channel impoundment), and FPS (flowing point source or NPDES discharge).

## **Sampling Design and Site Selection**

Systematic and purposive sampling methods were used to select survey sites on project streams. Using the TCEQ stream shapefiles, survey stations were generally evenly spaced every 1.67 miles or 3 points per 5 mile segment of stream. This methodology ensured that the survey sites provide a representative sample of the conditions that exist along the entire population of streams. In order to ensure that recreational use was targeted for measurement, evenly spaced points were replaced with sites near these points where recreation was most likely to occur. These targeted areas of recreational use included public parks, bridges, and other areas that are accessible to recreational users. Every effort was made to survey all sites. Some survey sites, however, were not sampled due to the lack of permission from private property owners. In these cases, alternative sites were found and surveyed whenever possible.

## **Collected Data for Each Stream Survey Sites**

Field data was collected based on TCEQ's Recreational Use Attainability Analyses Procedures for a Comprehensive RUAA and a Basic RUAA Survey (May 2009). Following these procedures, Contact Information Forms (Appendix 2), RUAA Summaries (Appendix 5), Field Data Sheets (Appendix 3), and Comprehensive RUAA Interview Form (Appendix 4) were completed for each RUAA stream survey site. Monthly Palmer Hydrological Drought Index data was obtained NOAA's National Climatic Data Center's National Environmental Satellite, Data, and Information Service website (<http://www.ncdc.noaa.gov/oa/climate/monitoring/drought/>). Daily precipitation data was obtained from NOAA's National Climatic Data Center (<http://cdo.ncdc.noaa.gov/dly/DLY>). Averaged daily precipitation data was used to produce preceding 30 day and 7 day precipitation summary statistics.

In the process of conducting recreational use interviews, interviewees were asked if children, teenagers, and/or adults recreate on the stream. This information was collected for interviewees and their family, other recreational users that they have observed on the stream, and recreational users they have heard about.

## **Statistical Analyses**

Basic statistical analyses were used to summarize collected RUAA data. Quantitative data such as average thalweg, average discharge, and average precipitation were determined by calculating the mean. Categorical data was summarized by counting the number of occurrences or calculating the proportion of occurrence out of the total number recorded.

## **Completion of RUAA Summaries**

The average thalweg for each stream was determined by calculating the mean thalweg for each survey site and then the mean of these means for each stream. Microsoft Autofilter was used to sort the data and determine which streams had substantial pools deeper than 1 m. Observations on use and the general level of public access were determined by using multiple sources of information. Observations on use including primary contact, secondary contact (1 & 2), and noncontact recreation activities were primarily determined by considering information provided by interviews with land owners surrounding the streams. The second factor considered came from the information recorded by survey teams, and the last factor considered were field observations of indications of human use at survey sites. The general level of public access was determined primarily by survey team's responses to "Describe Access Opportunities" for each survey site and secondarily on "Bank Access", "Surrounding Conditions that Impede Recreation", and the number of recreation areas located for each stream.

## Results

### Contact Information Forms

In completing the Contact Information Forms for each stream, 88 individuals from state, federal, local and agencies and groups were contacted of which a total of 28 individuals answered the form's questions. Of the 28 individuals, 15 believed (Brazos 3, East Yegua 3, Lower Cibolo 4, and Navasota 5) an RUAA survey is appropriate (Table 1). Individuals confirmed primary recreation on the Brazos, 4, East Yegua, 1, and Lower Cibolo, 4, but not for the Navasota. Individuals confirmed secondary contact 1 (Brazos 5, East Yegua 4, Lower Cibolo 4, and Navasota 4) and 2 (Brazos 7, East Yegua 5, Lower Cibolo 6, and Navasota 6) and noncontact recreation (Brazos 4, East Yegua 2, Lower Cibolo 7, and Navasota 4) for all waterways (Table 2). Reasons for no recreation observed for the Brazos included limited access due to private property and muddy river; for the East Yegua low flow and water, limited access due to private property, and dangerous conditions; for the Lower Cibolo intermittent flow, not enough water, limited access due to private property, and dangerous conditions; and for the Navasota not enough water, physical characteristics of river (turbidity and silt load), and limited access due to private property.

The frequency of recreation classifications varied between the waterways. No recreation occurred on a daily basis for all waterways. For the Brazos primary recreation rarely occurred and the reported frequency of unknown, 5, and yearly, 2. The responses to secondary 1 and 2 and noncontact varied between interviewed individuals for all waterways. The frequency of the three other recreational classifications were reported on the Brazos as follows: secondary 1, never 0, unknown 3, yearly 2, monthly 2; for secondary 2, never 0, unknown 1, yearly 4, monthly 2; and for noncontact, never 0, unknown 4, yearly 1, and monthly, 2 (Table 2). The East Yegua and Navasota displayed similar results. Individuals interviewed reported primary contact as the least frequent activity observed in both of these waterways; East Yegua, unknown 5 and never 1 and Navasota, unknown 5 and never 1. For the East Yegua the frequency of the three other recreational classifications were reported as follows: secondary 1, never 1, unknown 2, yearly 0, and monthly 3; for secondary 2, never 0, unknown 2, yearly 1, monthly 3; and for

noncontact, never 0, unknown 5, yearly 0, and monthly 1 (Table 2). For the Navasota the frequency of the three other recreational classifications were reported as follows: secondary 1, never 1, unknown 2, yearly 1, and monthly 2; for secondary 2, never 0, unknown 2, yearly 1, monthly 3; and for noncontact, never 0, unknown 3, yearly 1, and monthly 2 (Table 2). Individuals interviewed for the Lower Cibolo reported a higher frequency of primary recreation with occurrences of yearly, 1, and monthly, 3; however, 2 individuals reported never observing recreation and 3 reported unknown. The frequency for the other recreational classification were as follows: secondary 1, never 1, unknown 4, yearly 0, and monthly 4; secondary 2, never 1, unknown 2, yearly 1, and monthly 5; and noncontact, never 0, unknown 2, yearly 3, and monthly 4 (Table 2).



Table 1. Summary of interviewees' responses to the RUAA Contact Information Form

Rivers and Creeks	Number Interviewed	RUAA Appropriate	RUAA Not Appropriate	Recreation Observed							
				Primary		Secondary 1		Secondary 2		Noncontact	
				Yes	No	Yes	No	Yes	No	Yes	No
Brazos River Above Possum Kingdom Lake	7	3	4	4	3	5	2	7	0	4	3
East Yegua Creek	6	3	3	1	5	4	2	5	1	2	4
Lower Cibolo Creek	9	4	5	4	5	4	5	6	3	7	2
Navasota River Above Lake Mexia	6	5	1	0	6	4	2	6	0	4	2
<b>Total</b>	<b>28</b>	<b>15</b>	<b>13</b>	<b>9</b>	<b>19</b>	<b>17</b>	<b>11</b>	<b>24</b>	<b>4</b>	<b>17</b>	<b>11</b>

Table 2. Frequency of recreational activities on the Brazos River (1208), East Yegua Creek (1212B), Lower Cibolo Creek (1902), and the Navasota River (1210A) based on responses to the Contact Information Forms.

<b>Rivers and Creeks</b>	<b>Primary</b>	<b>Secondary 1</b>	<b>Secondary 2</b>	<b>Noncontact</b>
<b>Brazos River</b>				
Never	0	0	0	0
Unknown	5	3	1	4
Yearly	2	2	4	1
Monthly	0	2	2	2
Daily	0	0	0	0
<b>East Yegua Creek</b>				
Never	1	1	0	0
Unknown	5	2	2	5
Yearly	0	0	1	0
Monthly	0	3	3	1
Daily	0	0	0	0
<b>Lower Cibolo Creek</b>				
Never	2	1	1	0
Unknown	3	4	2	2
Yearly	1	0	1	3
Monthly	3	4	5	4
Daily	0	0	0	0
<b>Navasota River</b>				
Never	1	1	0	0
Unknown	5	2	2	3
Yearly	0	1	1	1
Monthly	0	2	3	2
Daily	0	0	0	0

## General Stream Characteristics

Three hundred and thirty-five miles of streams were evaluated with 236 surveys (Table 3). A total of 147 surveys were completed to evaluate recreation on the 189 miles of the Brazos River Above Possum Kingdom. Sixty nine, fifteen, and five total surveys were completed on the Lower Cibolo Creek, East Yegua Creek, and the Navasota River Above Lake Mexia, respectively.

Two publicly owned recreation areas, Lake Somerville Wildlife Management Area and Irwin Bridge, were found on East Yegua Creek at survey points 1212B.25 and 1212B.26, respectively. One publicly owned recreation area (Crescent Bend Nature Park) was found on the Lower Cibolo Creek at survey point 1902.1 and 1902.2. No publically owned recreation areas were found on the Brazos River, or the Navasota River. Both the Brazos River and the Lower Cibolo Creek, however, had privately owned recreation areas that were easily accessible and widely used by local residents such as survey point such as 1208.10 and 1902.33 Alt, respectively.

Shrubs were the dominant riparian zone recorded for all streams 48% followed by forest (33%), denuded/eroded bank (6%), pasture (5%), and herbaceous marsh (4%) (Table 4). Eighty four percent of the Brazos River riparian zone is shrub and forest followed by Lower Cibolo Creek (82%), Navasota River (75%), and East Yegua Creek (51%). The riparian zone of East Yegua Creek had the largest percentage of pasture (36%) followed by the Navasota River (13%), Lower Cibolo Creek (4%), and the Brazos River (2%).

Seven hydrologic stream measurements including continuous and categorical hydrologic field observations were collected during the RUAA to provide a measure of the amount of water in each RUAA stream (Table 5). The Brazos River had the largest average width (47.4 m), thalweg (0.7 m), and flow (331.5 ft/s). Field teams characterized the Brazos River as perennial 99% of the time and as having water for primary contact 95% of the time. The Lower Cibolo Creek had an average width of 12.8 m, thalweg of 0.8 m, and flow of 32.8 ft/s. Field technicians characterized it as perennial 80% of the time and as having enough water for primary contact 96% of the time. The Navasota River had an average width of 3.8 m, thalweg of 0.5 m, and flow of 2.3 ft/s. Field technicians characterized it as intermittent with perennial pools 60% of the time and as having enough water for primary contact 40% of the time. East Yegua Creek had an

average width of 6.7 m, thalweg of 0.4 m, and flow of 37.8 ft/s. Field technicians characterized it as perennial 67% of the time and as having enough water for primary contact 47% of the time.

Based on the tx wastewtr outfall shapefile, one industrial wastewater outfall and one domestic sewage outfall less than 1 MGD are located on the Brazos River in the vicinity of the city of Seymour (Appendix 1). East Yegua Creek has one industrial wastewater outfall located in the vicinity of survey point 1212B.3. The Lower Cibolo Creek has one domestic wastewater treatment plant outfall greater than or equal to 1 MGD located 1000 meters upstream of survey point 1902.1 in the city of Schertz and one domestic sewage outfall less than 1 MGD located in the town of La Vernia.

The RUAA summary analysis for each stream (Table 6) indicates that primary contact frequently occurs on the Brazos River and the Lower Cibolo Creek and seldom occurs on East Yegua Creek or the Navasota River. Secondary contact recreation 1 activities frequently occur on the Brazos River and the Lower Cibolo Creek and seldom occur on the Navasota River. Based on the limited information collected, it is unknown whether secondary contact recreation 1 activities occur on East Yegua Creek. The Brazos River, Navasota River, and the Lower Cibolo Creek had average thalwegs greater or equal to 0.5 m. All four streams had substantial pools. General public access was moderate on the Brazos River and the Lower Cibolo Creek and very limited for East Yegua Creek and the Navasota River.

Table 3. General RUAA stream characteristics.

<b>Stream</b>	<b>Waterbody Name</b>	<b>Stream Type</b>	<b>Total Stream Miles</b>	<b># of First Surveys</b>	<b># of Second Surveys</b>	<b>Total</b>
1208	Brazos River Above Possum Kingdom Lake	Classified	189	75	72	<b>147</b>
1210A	Navasota River Above Lake Mexia	Unclassified	25	5	0	<b>5</b>
1212B	East Yegua Creek	Unclassified	42	15	0	<b>15</b>
1902	Lower Cibolo Creek	Classified	79	35	34	<b>69</b>
		<b>Total</b>	<b>335</b>	<b>130</b>	<b>106</b>	<b>236</b>

Table 4. Sum of the left bank and right bank riparian zone corridor categorical observations with the percent of the dominant riparian zone categories calculated for each stream.

<b>Stream</b>	<b>Shrub dominated corridor</b>	<b>% Shrub dominated corridor</b>	<b>Forest</b>	<b>% Forest</b>	<b>Denuded/Eroded bank</b>	<b>% Denuded/Eroded bank</b>	<b>Pasture</b>	<b>% Pasture</b>	<b>Herbaceous marsh</b>	<b>% Herbaceous marsh</b>
<b>1208</b>	230	56	116	28	22	5	10	2	21	5
<b>1210A</b>	4	25	8	50	2	13	2	13	0	0
<b>1212B</b>	13	29	10	22	1	2	16	36	2	4
<b>1902</b>	81	39	90	43	13	6	9	4	7	3
<b>Totals</b>	<b>328</b>	<b>48</b>	<b>224</b>	<b>33</b>	<b>38</b>	<b>6</b>	<b>37</b>	<b>5</b>	<b>30</b>	<b>4</b>

Table 5. Hydrologic stream characteristics with the proportion of recorded categorical field observations of the total for each stream.

<b>Stream</b>	<b>Avg Width (m)</b>	<b>Avg Thalweg (m)</b>	<b>Avg Flow (ft/s)</b>	<b>Flow Prop.</b>	<b>Stream Type Proportion</b>	<b>Channel Proportion</b>	<b>Water for Prim Contact? Prop.</b>
<b>1208</b>	47.4	0.7	331.5	0.51 Normal	0.99 Perennial	0.54 Non-wadeable	0.95 Yes
				0.20 Flooded	0.01 Intermittent w/per. pools	0.46 Wadeable	0.05 No
				0.09 High			
				0.08 Low			
				0.07 Normal/High			
				0.02 Normal/Flooded			
				0.01 High/Flooded			
				0.01 No data recorded			
<b>1210A</b>	3.8	0.5	2.3	0.60 No flow	0.60 Intermittent w/per. pools	1.00 Wadeable	0.60 No
				0.40 Normal	0.40 Ephemeral		0.40 Yes
<b>1212B</b>	6.7	0.4	37.8	0.73 Normal	0.67 Perennial	0.73 Wadeable	0.53 No
				0.13 Dry	0.20 Ephemeral	0.27 Non-wadeable	0.47 Yes
				0.07 Low	0.13 Intermittent w/per. pools		
				0.07 No flow			
<b>1902</b>	12.8	0.8	32.8	0.84 Normal	0.80 Perennial	0.66 Wadeable	0.96 Yes
				0.11 Low	0.20 Intermittent w/per. pools	0.34 Non-wadeable	0.04 No
				0.03 No flow			
				0.01 High			

Table 6. RUAA summary for each stream.

Stream Name	Brazos River	East Yegua Creek	Navasota River	L. Cibolo Creek
Segment Number	1208	1212B	1210A	1902
Classified?	Yes	No	No	Yes
Primary contact	frequently	seldom	seldom	frequently
Sec. Contact Rec. 1	frequently	unknown	seldom	frequently
Sec. Contact Rec. 2	frequently	seldom	seldom	frequently
Noncontact	frequently	seldom	seldom	frequently
Avg Thalweg	0.7m	0.4m	0.5m	0.8m
Subst pools > 1m	Yes	Yes	Yes	Yes
Gen Public Access	Moderate	Very Limited	Very Limited	Moderate
PDSI	Mod. to Extrem. Moist	Mid-range	Mid-range	Mod. Moist

## **Observations and Evidence of Recreational Use and Surrounding Conditions that Promote and Impede Recreation**

Twenty one primary contact recreation activities and 52 secondary contact recreation activities were observed during the duration of 2010 RUAA field work (Table 7). Seven people on the Brazos River and 14 on the Lower Cibolo Creek were observed carrying out primary contact recreation activities. These activities included swimming, tubing, diving, and wading children. Twelve people on the Brazos River and 40 people on the Lower Cibolo Creek were observed carrying out secondary contact recreation activities. Various noncontact activities were observed on both the Brazos River and the Lower Cibolo Creek. No primary, secondary, or noncontact activities were observed on the Navasota River or East Yegua Creek.

One hundred and thirteen Indications of Human Use relating to Primary and Secondary I Contact were recorded for the Lower Cibolo Creek followed by 35 for the Brazos River and 4 for East Yegua Creek (Table 8). Sixteen IHUs relating to Primary contact recorded for the Lower Cibolo Creek included rope swings (8), zip line (1), inner tube (1), and 6 docks or platforms. Two docks or platforms were the only IHU relating to Primary contact that were recorded for the Brazos River. Thirty eight IHUs relating to Secondary contact 1 were recorded on the Lower Cibolo Creek followed by 11 for the Brazos River. These included children's toys, remnants of kid's play, canoe/kayaks, boats, and drag marks from a boat. IHUs related to possible fish consumption were recorded for the Brazos River (22), Lower Cibolo Creek (59), and East Yegua Creek (4). IHUs related to structural amenities and access, and miscellaneous indications are summarized in Table 9 and Table 10, respectively.

Surroundings conditions (SC) that promote recreation are summarized in Table 11 and Table 12. Eight SC that promote Primary and Secondary I Contact were recorded for the Lower Cibolo Creek followed by 7 for the Brazos River. SC relating to amenities were recorded for the Brazos River (181), Navasota River (5), East Yegua Creek (20), and the Lower Cibolo Creek (154). SC relating the condition of the stream bank were found on all RUAA streams.

Surroundings conditions (SC) that impede recreation and channel obstructions are summarized in Table 13 and Table 14, respectively. Surroundings conditions that impede recreation were categorized under the categories of no access, warning signs, obstacles, and other. No access was recorded as impeding recreation, on the Brazos River (169), Navasota River (1), East Yegua Creek (11), and the Lower Cibolo Creek (40). Warning signs were also recorded as impeding recreation, on the Brazos River (125), Navasota River (5), East Yegua Creek (10), and the Lower Cibolo Creek (58). Obstacles and Other SC that impede recreation were recorded for all four RUAA streams. Channel obstructions were recorded for the Brazos River (17), Navasota River (5), East Yegua Creek (14), and the Lower Cibolo Creek (37). Log jams, low bridges, and bridge pillars were the most frequent channel obstructions recorded.



Table 7. Recreation Activities observed during RUAA field surveys.

<b>Seg ID</b>	<b>Date</b>	<b>Primary contact recreation activities</b>	<b>Count</b>
1208.76	6/26/2010	Swimming	2
1208.85	8/7/2010	Tubing	5
1902.12	7/31/2010	Swimming	5
1902.33ALT	8/28/2010	Wading-Children	2
1902.36ALT	8/21/2010	Swimming & Diving	1
1902.36ALT	8/28/2010	Swimming	3
1902.39	7/18/2010	Swimming	3
<b>Total</b>			<b>21</b>
<b>Secondary contact recreation activities</b>			<b>Count</b>
1208.69	6/26/2010	Other (Individual is on shore within 8 m of water)	1
1208.76	6/26/2010	Fishing	2
1208.89	7/24/2010	Other (walking on bank)	2
1208.112	6/26/2010	Other (Playing fetch with dog that swam in river)	1
1208.113	7/24/2010	Other (pwc - personal watercraft)	2
1208.114	7/24/2010	Other (fishing from boat)	4
1902.1	7/31/2010	Fishing	1
1902.2	7/17/2010	Fishing	6
1902.2	7/31/2010	Fishing	4
1902.9	7/17/2010	Fishing	2
1902.11	7/31/2010	Non-whitewater-kayaking, rafting, canoeing	3
1902.16	7/31/2010	Fishing	3
1902.17	7/31/2010	Fishing	3
1902.28	7/18/2010	Fishing	4
1902.31	7/18/2010	Fishing	2
1902.31	7/18/2010	Whitewater-kayaking, canoeing, rafting	2
1902.33ALT	8/22/2010	Fishing	5
1902.33ALT	8/28/2010	Other (sitting in chair supervising daughter and dog)	1
1902.36ALT	8/21/2010	Other (standing within 8m of stream)	4
<b>Total</b>			<b>52</b>
<b>Noncontact activities</b>			
1208.69	6/26/2010	Other (Shooting on sand bank)	
1208.69	6/26/2010	Motorcycle/ATV	
1208.69	6/26/2010	Motorcycle/ATV	
1208.69	6/26/2010	Sitting	
1208.76	6/26/2010	Walking	
1208.89	7/24/2010	Walking	
1902.1	7/17/2010	Standing	
1902.2	7/31/2010	Walking	
1902.18	7/31/2010	Standing	
1902.18	7/31/2010	Walking	
1902.28	7/18/2010	Playing on shoreline	
1902.33ALT	8/22/2010	Playing on shoreline	
1902.33ALT	8/22/2010	Sitting	
1902.33ALT	8/22/2010	Standing	
1902.33ALT	8/22/2010	Motorcycle/ATV	
1902.33ALT	8/28/2010	Playing on shoreline	
1902.33ALT	8/28/2010	Sitting	
1902.36ALT	8/21/2010	Standing	
1902.36ALT	8/21/2010	Playing on shoreline	

Table 8. Indications of Human Use (IHU) recorded during field surveys related to primary contact and secondary contact 1 activities. Values represent the total for each stream.

	<b>Brazos River</b>	<b>Navasota River</b>	<b>East Yegua Creek</b>	<b>Lower Cibolo Creek</b>
<b>IHU related to primary contact</b>				
Rope swings				8
Zip line across stream				1
Inner tube				1
Dock or platform	2			6
<b>Sub Total</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>16</b>
<b>IHU related to secondary contact 1</b>				
Children's toys	1			1
Remnant's of Kid's play				1
Canoe/kayak	1			2
Boat	4			2
Drag marks from boat	1			
<b>Sub Total</b>	<b>7</b>	<b>0</b>	<b>0</b>	<b>6</b>
<b>IHU related to secondary contact 1/potential fish consumption</b>				
Dead fish on display				1
Fish remnants				2
Fishing tackle	17		3	47
Pole				1
Fishing net				1
Bait carton	1		1	3
Trot line, trash	1			
Fish skinning stand next to river	1			
Fishing area				1
Picnic & fishing area				1
Fishing pole holders	2			2
<b>Sub Total</b>	<b>22</b>	<b>0</b>	<b>4</b>	<b>59</b>
<b>Total</b>	<b>35</b>	<b>0</b>	<b>4</b>	<b>113</b>

Table 9. Indications of human use (IHU) recorded during field surveys related to structural amenities and access. Values represent the total for each stream.

	<b>Brazos River</b>	<b>Navasota River</b>	<b>East Yegua Creek</b>	<b>Lower Cibolo Creek</b>
<b>IHU related to structural amenities</b>				
House adjacent to stream	1			
House overlooking river	1			
Cabin adjacent to stream				1
Private recreation area	1			
Picnic area	1			
Picnic table/s	2			1
BBQ grill	2			2
Camping sites	2			6
Fire pit/ring	11			9
Chair/s	4			6
Swing	1			
Lights				1
Trash can			1	
Stumps for sitting				1
<b>Sub Total</b>	<b>26</b>	<b>0</b>	<b>1</b>	<b>27</b>
<b>IHU related to access</b>				
Gates on corridor	2			
Pedestrian gate	1			
Stairs leading to river	1			
Wooden ladder for crossing over fence	1			
Ladder				1
Flagged trail	1			
Foot paths or prints	11			10
Bicycle tracks	1			1
RV/ATV Tracks	10			6
Truck path	4			2
Tractor path	1			
Bulldozer path to stream				1
Roads	5		1	9
<b>Sub Total</b>	<b>38</b>	<b>0</b>	<b>1</b>	<b>30</b>
<b>Total</b>	<b>64</b>	<b>0</b>	<b>2</b>	<b>57</b>

Table 10. Miscellaneous Indications of Human Use (IHU) recorded during field surveys. Values represent the total for each stream.

	<b>Brazos River</b>	<b>Navasota River</b>	<b>East Yegua Creek</b>	<b>Lower Cibolo Creek</b>
<b>Miscellaneous IHU</b>				
Boombox				1
Camping lantern	1			
Clothing	1			1
Wash board				1
Beer cans or bottles	3			5
Soda cans	1			
Fireworks	1			
Graffiti	4			
Shotgun shells	12		1	3
Feeder stand	6			
Hunting stand	10		1	
Hunting trailer	1			
Vehicles at bridge crossing				2
<b>Sub Total</b>	<b>40</b>	<b>0</b>	<b>2</b>	<b>13</b>

Table 11. Surrounding conditions that promote primary and secondary contact 1 recreation recorded during field surveys for each stream.

	<b>Brazos River</b>	<b>Navasota River</b>	<b>East Yegua Creek</b>	<b>Lower Cibolo Creek</b>
<b>Surrounding conditions that promote prim. cont. activities</b>				
Rope swing and chairs on right bank				1
Boat docks or rafts				3
Beach	3			1
Cliff for jumping into river	1			
<b>Subtotal</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>5</b>
<b>Surrounding conditions that promote sec. cont. 1 activities</b>				
Boating access (ramps)	2			2
Trot line				1
Bench and fishing rod holders	1			
<b>Subtotal</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Total</b>	<b>7</b>	<b>0</b>	<b>0</b>	<b>8</b>

Table 12. Surrounding conditions that promote all types of recreation recorded during field surveys for each stream.

	<b>Brazos River</b>	<b>Navasota River</b>	<b>East Yegua Creek</b>	<b>Lower Cibolo Creek</b>
<b>Amenities</b>				
Parks (national/city/county/state)			1	3
Sports Field				1
Campgrounds	3			2
Public Property			1	7
Paved parking lot				2
Unimproved parking lot	3		1	5
Bench area	1			
Watch tower for hunting	1		1	
Stairs/walk-way	4			3
Trails/paths (foot/truck)	2			
Trails/paths (hiking/biking)	1			9
Bridge crossing	20		5	40
Roads (paved/unpaved)	20	4	4	24
Residential				2
Urban/sub-urban location				1
Vehicle trail	1			
Cabin near stream				1
Private gate and road	1			
Private truck path	1			
Gate accessing river	2			
Power Line Corridor				1
Clear bulldozer path				2
Rural area	121	1	7	51
	<b>SubTotal</b>	<b>181</b>	<b>5</b>	<b>20</b>
<b>Condition of stream bank</b>				
Cleared bank area	1			
Man made clearing				1
Maintained corridor on right bank	1			
Clearing by water crossing				1
Sand bank	2			
Long, bare river bank	1			
Flattened bank area	1			
Low water crossing path	1			1
Gradual sloping area used for river access	1			
Wildlife	49			3
Wild plums and relatively pristine	1			
	<b>SubTotal</b>	<b>58</b>	<b>0</b>	<b>0</b>
	<b>Total</b>	<b>239</b>	<b>5</b>	<b>160</b>

Table 13. Characteristics that impede recreation recorded during field surveys for each stream.

	<b>Brazos River</b>	<b>Navasota River</b>	<b>East Yegua Creek</b>	<b>Lower Cibolo Creek</b>
<b>No access</b>				
No public access	111	1	7	33
No roads	58		4	7
<b>SubTotal</b>	<b>169</b>	<b>1</b>	<b>11</b>	<b>40</b>
<b>Warning signs</b>				
No trespass sign	8	1		11
Warning sign	1			
Private Property	116	4	10	47
<b>SubTotal</b>	<b>125</b>	<b>5</b>	<b>10</b>	<b>58</b>
<b>Obstacles</b>				
Barbed wire	1			
Fence	67	4	3	20
Dense vegetation	12		1	1
Cliffs	1			
Steep slopes	21		4	16
Thick mud			1	
<b>SubTotal</b>	<b>102</b>	<b>4</b>	<b>9</b>	<b>37</b>
<b>Other</b>				
Dry channel		1	1	
Flooded condition	4			
Wildlife	5			
Graffiti	1			
Natural gas pipeline			1	
No public amenities	1			
Scum				1
<b>SubTotal</b>	<b>11</b>	<b>1</b>	<b>2</b>	<b>1</b>
<b>Total</b>	<b>407</b>	<b>11</b>	<b>32</b>	<b>136</b>

Table 14. Channel obstructions recorded during field surveys for each stream.

	<b>Brazos River</b>	<b>Navasota River</b>	<b>East Yegua Creek</b>	<b>Lower Cibolo Creek</b>
Thick vegetation			1	1
Fence(s)		2		
Log jams		1	9	12
Dams				1
Culverts		1	1	2
Low bridges			2	11
Bridge pillars	10			2
Remnants of bridge	2	1		5
Road support columns				1
Metal piping				1
Utility pipe			1	
Natural island	3			1
Rocks	1			
Sand bar	1			
<b>Total</b>	<b>17</b>	<b>5</b>	<b>14</b>	<b>37</b>

## Recreational Use Interviews

### Classified Stream Segment 1208 (Brazos River Above Possum Kingdom):

Four hundred and ninety four mailed letters and 552 phone messages sent or left, respectively, to Brazos River area residents resulted in the completion of 82 recreational use interviews. The majority of the people that participated in the interviews were landowners (61%) with property adjacent to or in contact with the river as well as local residents (25.6 %) that live near the river. We also conducted seven interviews to groups of people that were recreating at the river at the time field surveys were being conducted (Fig. 59). Nine people refused to participate in the interview (Fig. 59).

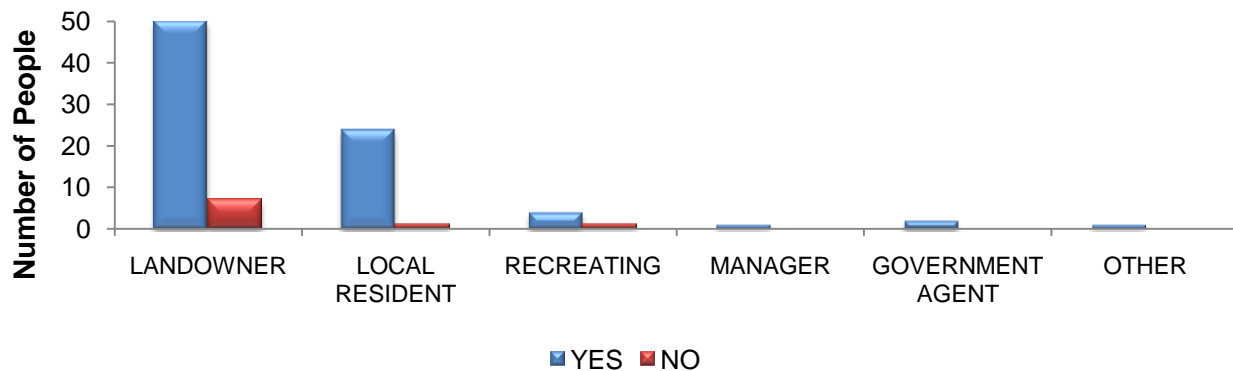


Figure 59. Number of people that participated in interviews assessing recreation in the Brazos River (Stream Segment 1208).

Out of 82 people that were willing to answer our questions, only three of them were not familiar with the stream segment. The majority of the people that were interviewed have been familiar with the stream segment for over 20 years (Table 15). Most of these people classified the stream as perennial or intermittent with perennial pools (Table 16).



Table 15. Number of years interviewees have been familiar with the Brazos River (1208) (n = 79) .

No. of Years Familiar	Percentage of Interviewees
≤5	14%
>5 <10	5%
10 – 20	19%
>20 <50	35%
≥ 50	26%

Table 16. Stream classification by interviewees which are familiar with portions of the Brazos River (Stream Segment 1208) (n = 79).

People's Classification	Percentage of Interviewees
1. Ephemeral	5%
2. Intermittent	10%
3. Intermittent w/ perennial pools	31%
4. Perennial	49%
5. N/A	5%

Excluding four interviewees (two state or federal agents, a land manager, and a person who sold the property), the majority of people that participated in the interviews use the river for recreation (70%). Hunting, fishing (both for catch and release and consumption), wading by children, and swimming were the main activities reported (Table 17).

Table 17. Recreational activities reported in the Brazos River at Stream Segment 1208 that involve the person that was interviewed and or his/her family. Note that a single interviewee can report one or more recreational activities.

Personal or Family Uses	Number of Reports
<b>Primary contact Recreation Activities</b>	
Cliff diving	1
Swimming	9
Tubing	2
Wading - Children	13
<b>Secondary contact Recreation Activities</b>	
Wading-Adults	4
Boating	8
Canoeing	6
Kayaking	2
Fishing (Catch and release)	22
Fishing (For consumption)	23
Night fishing	1
Playing on shore or banks	6
Sun-bathing	1
<b>Noncontact Recreation Activities</b>	
Barbeques, Picnics, and Parties	4
Camping	5
Fireworks	1
Hiking	1
Hunting	27
Shooting	1
Watching Wildlife or Nature	1

The majority of the people that reported recreating in this segment of the river are adults, although children and teenagers are also frequent users (Fig. 60). Over half of interviewees (55%) stated using the river for recreation between 1 to 30 days per year (average =  $11 \pm 8$  days/year), and 6% of interviewees use the river more than 300 days per year (average =  $360 \pm 9$  days/year). Among the interviewees that specifically stated using the river for primary and secondary contact recreation activities (i.e. swimming, tubing, diving, wading, boating including canoeing and kayaking, and fishing for both catch and release and consumption; n = 28), 61% reported using the river during 1 to 30 days

per year (average =  $10 \pm 8$  days/year), 14% during 31 to 90 days per year (average =  $45 \pm 10$  days/year), 11% during 91 to 181 days per year (average =  $127 \pm 46$  days/year), 4% during 200 days per year, and 7% more than 300 days per year (average =  $358 \pm 11$  days/year).

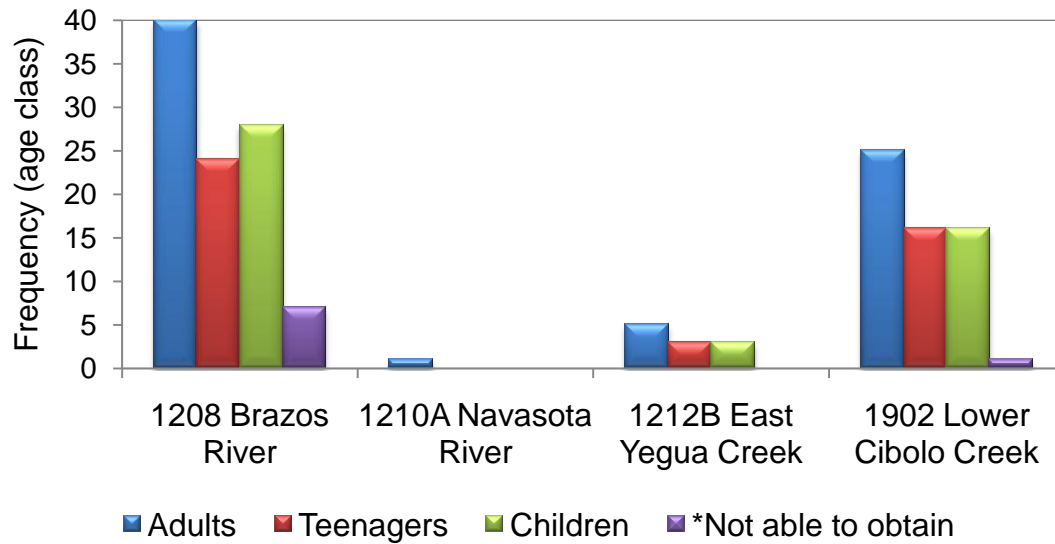


Figure 60. Age class frequencies of people participating in recreational activities per stream segment. Recreational activities involved the person that was interviewed and her/his family. \*Recreational activities were reported but the age class of people involved in such activities was not obtained during the interview.

Most of the interviewees that do not use the river for recreation have other personal interests or state that the water level is low for recreation. Other reasons given for not using the river were poor access and water quality (water is muddy and becomes salty during low flow) (Table 18).

Table 18. Reasons stated by interviewees for not using the Brazos River at Stream Segment 1208. Percentages are based on 25 people that stated not using the river.

Reasons for Not Using the River	Percentage of Interviewees
Other personal interests (Do not Specify)	32%
Physical characteristics (Low or No water)	20%
Physical characteristics (Poor access)	12%
Physical characteristics (Water quality)	8%
Potentially dangerous wildlife (wild hogs)	4%
Other (Leased for hunting)	4%
Other (Not on property)	4%

Interviewees had witnessed a large variety of recreation activities in this segment of the river (Table 19). The most frequently witnessed activities were fishing (for both consumption and catch and release), hunting, camping, canoeing and boating. Witnessed recreation activities involved mostly adults (43% of cases), but teenagers (35%) and children (22%) were also witnessed recreating.

Table 19. Recreational activities witnessed in the Brazos River at Stream Segment 1208 by interviewees. Note that a single interviewee can report one or more witnessed recreational activities

Witnessed Recreational Activities	Number of Reports
<b>Primary Contact Recreation Activities</b>	
Cliff diving	1
Jet skiing	1
Organized Tubing (10 tubes and blow up rafts with 40 or more teenagers)	2
Swimming	8
Tubing	4
Wading - Children	3
<b>Secondary Contact Recreation Activities</b>	
Wading-Adults	3
Boating	10
Air Boating	4
Canoeing	10
Fishing (Catch and release)	19
Fishing (For consumption)	16
Fishing (Use not specified)	1
Night fishing	1
Sun-bathing	1
Playing on shore or banks	4
<b>Noncontact Recreation Activities</b>	
Barbeques, Picnics, and Parties	1
Camping	12
4- wheeling	7
Hunting	16
Trapping	1
Treasure hunting	1

Thirty seven percent of interviewees have not witnessed recreation in this segment of the Brazos River (excluding four interviewees: two state or federal agents, a land manager, and a person who sold the property).

Interviewees also reported hearing of a large variety of recreation activities occurring in this segment of the river (Table 20). The most frequent activities that people have heard of occurring in the river were fishing (for both consumption and catch and release) and hunting. Excluding four interviewees (same as above), 33% of interviewees have not heard of recreation occurring in this segment of the Brazos River.

Table 20. Recreational activities that interviewees have heard of occurring in the Brazos River at Stream Segment 1208. Note that a single interviewee can report hearing of one or more recreational activities.

Recreational Act. Heard of Occurring in the River	Number of Reports
<b>Primary Contact Recreation Activities</b>	
Cliff diving	1
Swimming	7
Tubing	7
Wading - Children	2
<b>Secondary Contact Recreation Activities</b>	
Wading-Adults	2
Air boating	1
Boating	5
Canoeing	9
Kayaking	1
Fishing (Catch and release)	17
Fishing (For consumption)	12
Sun-bathing	1
Playing on shore or banks	3
<b>Noncontact Recreation Activities</b>	
Barbeques, Picnics, and Parties	1
Camping	8
4-Wheeling	10
4-Wheeling (Illegal)	1
Hunting	19
Hunting (Illegal)	1
Trapping	1

Reports of personal and family recreational activities by interviewees, in this segment of the Brazos River, date back to the 1940's. Wading of children and swimming appear to be recurrent recreational activities since the 1950's (Fig. 61a). Fishing, both for consumption and for catch and release, has been occurring since the 1940's and seems to be a prevailing recreational activity in this segment of the river. Boating has also been occurring since the 1950's along with canoeing and kayaking (Fig. 61b). Among noncontact recreational activities, hunting has been occurring since the 1950's and seems to be a prevailing activity since the 1990's (Fig. 61c).

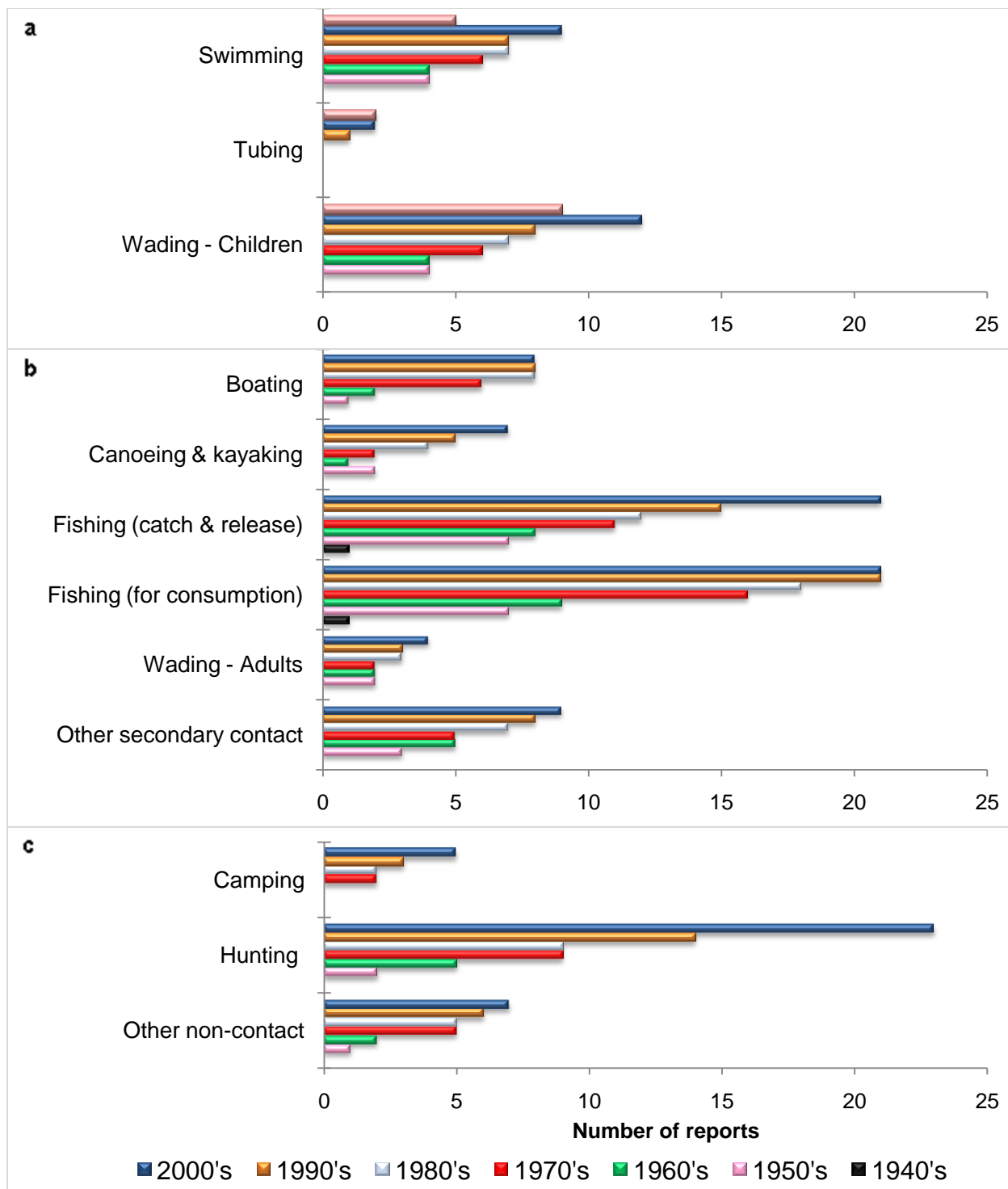


Figure 61. Recreational activities in the Brazos River (Segment 1208) per decade. **a)** Primary contact activities (swimming includes one report of cliff diving); **b)** Secondary contact activities (other includes night fishing, playing on shore or banks, and sun-bathing); **c)** Non-contact activities (other includes hiking, barbeques, picnics and parties; shutting fire arms; and watching wildlife or nature). The 2000's extend from 2000 to 2010.

Slightly more than half of the interviewees stated that recreational activities in segment 1208 of the Brazos River have changed through time. Some of the reasons most frequently stated by interviewees for different recreational use were changes in water level, water quality and physical characteristics of the river bed, which based on the responses to the questionnaire, seem to be associated to increased sedimentation over time (Fig. 62). Several people stated that as sedimentation increases, sediments accumulate on the river bed and banks lowering water level, and affecting fish habitat. For instance one person mentioned that under bank holes used by fish became filled with sediments and fish populations have decreased.

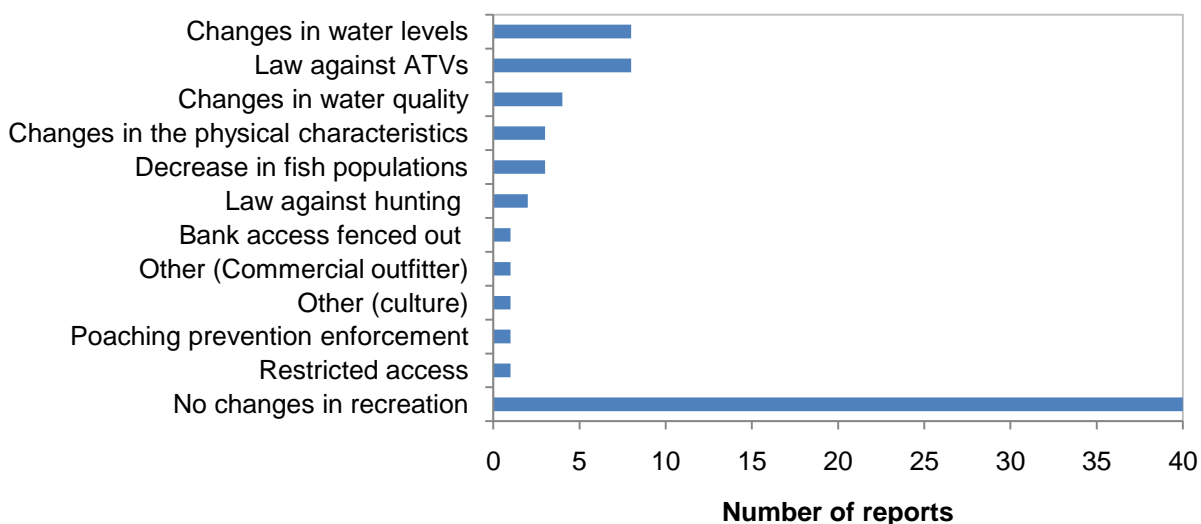


Figure 62. Reasons stated by interviewees for changes in recreational activities in the Brazos River (Segment 1208). These answers were obtained from 82 interviewees, 50 of which were landowners with full access to the river.

Despite the changes in water quality and physical conditions stated by several interviewees, current primary contact activities involving the person who was interviewed and his or her family seem to have increased in segment 1208 with respect to the past. Most secondary contact and noncontact recreational activities have also increased. Three noncontact recreational activities that characterized the segment in the past, however, seem to no longer occur (i.e. 4-wheeling, poaching/trapping, and riding horses), but two of them (i.e. 4-wheeling and poaching) are now prohibited by law (Table 21).



Table 21. Comparison of recreational activities that characterized the Brazos River Above Possum Kingdom (Segment 1208) in the past, versus current personal &/or family recreational activities reported by interviewees

	Past	Present	Change
<b>Primary contact Recreation Activities</b>			
Cliff diving	0	1	increase
Swimming	6	9	increase
Tubing	1	2	increase
Wading - Children	1	13	increase
<b>Secondary contact Recreation Activities</b>			
Air boating	1	0	Not reported in present
Boating	10	8	decrease
Canoeing	4	6	increase
Kayaking	0	2	increase
Fishing (Catch and release)	14	22	increase
Fishing (For consumption)	17	23	increase
Night fishing	0	1	increase
Playing on shore or banks	3	6	increase
Wading-Adults	2	4	increase
Sun-bathing	1	1	none
<b>Noncontact Recreation Activities</b>			
Barbeques, Picnics, and Parties	1	4	increase
Camping	8	5	decrease
Fireworks	0	1	increase
Four-wheeling	9	0	Not reported in present
Hiking	0	1	increase
Hunting	15	27	increase
Poaching and trapping	2	0	Not reported in present
Riding horses	1	0	Not reported in present
Shooting	0	1	increase
Watching wildlife or nature	1	1	none

Other comments about recreational activities that occurred in the past or that continue occurring in this segment of the Brazos River are summarized in table 22.

Table 22. Interesting additional comments by interviewees about recreation in the Brazos River (Segment 1208).

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**Current Primary contact Activities:**

- Knox County High School teens tube downstream 5 to 10 times per year after heavy rains, in 10 or more rafts holding up to 40 people
- 200 meters downstream there is a cliff were people dive into the river. Young man is now in college, but in the past 4 years him and 4 to 10 of his friends will recreate at the river doing activities mentioned in this interview including swimming and cliff diving

**Current Secondary contact Activities:**

- Husband and wife were fishing in the river. He has been fishing for only two years. She has been fishing in the area for her entire life. She stated that more recreational uses occurred in the past when access to the river was easier.
- Middle aged husband and wife were fishing in the river. Lady said that a group of locals and old timers including her own family have been using this river frequently for their entire lives.
- Person has fished for catfish off bank and waded to put up trot lines.
- Person has only used the river and seen been used for fishing when flow is high.

**Past Recreational Activities:**

- Her family used to be able to swim in the river, but since the water level has declined over time they are not able to swim anymore.
  - Possum Kingdom impoundment and fish-kill 10 years ago have reduced recreation opportunities.
  - Person's property is located up-stream from Possum Kingdom Dam so water level is not appealing to tube or doing those such activities.
  - In the past five years campground got flooded and business has suffered and harder to maintain.
  - Lower population than counties to the south so it affects recreational use. Recreation is most likely quite infrequent.
  - Silty water conditions are a result of the Possum Kingdom Lake dam.
  - Do not use in summer because water becomes salty
  - Usage of stream has not changed, just increased due to commercial outfitter.
- 

**Unclassified Water Body 1210A (Navasota River Above Lake Mexia):**

Sixteen mailed letters and 22 phone messages sent or left, respectively, to Navasota River area residents resulted in the completion of 4 recreational use interviews. Three of them were landowners with property adjacent to the river and the fourth person was a land manager. The three landowners have

been familiar with the river for periods of 20, 51 and 70 years each. Two of these landowners classified the stream segment as intermittent while one classified the stream segment as ephemeral. One of the landowners and his family use the river for recreation (picnic and hunting with arrow), and in this case, only adults recreate in the river. He stated that he and his family use the river between 1 to 30 days per year and have been using the river for recreation since 1970. The two landowners that do not use the river argued that the water level is low for recreation.

Two landowners have witnessed picnics, arrow hunting and fishing (catch and release) in this segment of the Navasota River. Adults, as well as teenagers and children, have been witnessed recreating. One landowner has not witnessed or heard of recreation activities occurring in this stream segment. One landowner reported changes in recreational activities due to decreased water levels, where the river flows only after abundant rainfall. He reported that picnics were the characteristic recreational activity in this segment of the Navasota River in the past. One of the landowners that do not use the river for recreation said that recreation activities have not changed over time.

**Unclassified Water Body 1212B (East Yegua Creek):**

Thirty two mailed letters and 27 phone messages sent or left, respectively, to East Yegua Creek area residents resulted in the completion of 10 recreational use interviews. All of them were landowners with property adjacent to or crossed by the creek. The majority of them have been familiar with the stream for over 50 years (Table 23). Most of the interviewees classified the stream as intermittent with perennial pools or perennial (Table 24).

Table 23. Number of years interviewees are familiar with East Yegua Creek (Stream Segment 1212B) (n = 10).

No. of Years Familiar	Percentage of Interviewees
5	10%
10 -20	20%
>20<50	20%
≥ 50	40%

Table 24. Stream classification by interviewees which are familiar with portions of East Yegua Creek (Stream Segment 1212B) (n = 10).

People's Classification	Percentage of Interviewees
1. Ephemeral	10%
2. Intermittent	10%
3. Intermittent w/ perennial pools	50%
4. Perennial	30%

Over half of the people that were interviewed stated using the creek for recreation (60%). Hunting and fishing (catch and release) were the main activities reported (Table 25). The majority of people reported recreating in this stream segment are adults, although children and teenagers are also frequent users.

Table 25. Recreational activities reported in East Yegua Creek (Stream Segment 1212B) that involve the person that was interviewed and or his/her family. Notice that a single interviewee can report one or more recreational activities.

Personal or Family Uses	Number of Reports
<b>Secondary contact Recreation Activities</b>	
Fishing (Catch and release)	3
Fishing (For consumption)	2
<b>Noncontact Recreation Activities</b>	
Camping	1
Hiking	2
Hunting	4

All interviewees stated recreating in the creek between 1 to 30 days per year (average =  $9 \pm 5$  days/year). Recreational activities have been occurring in East Yegua Creek since the 1980's, although the majority of the interviewees have been recreating since the 2000's decade (Fig. 63). People that stated not recreating in the creek argued that the water level is low for recreation.

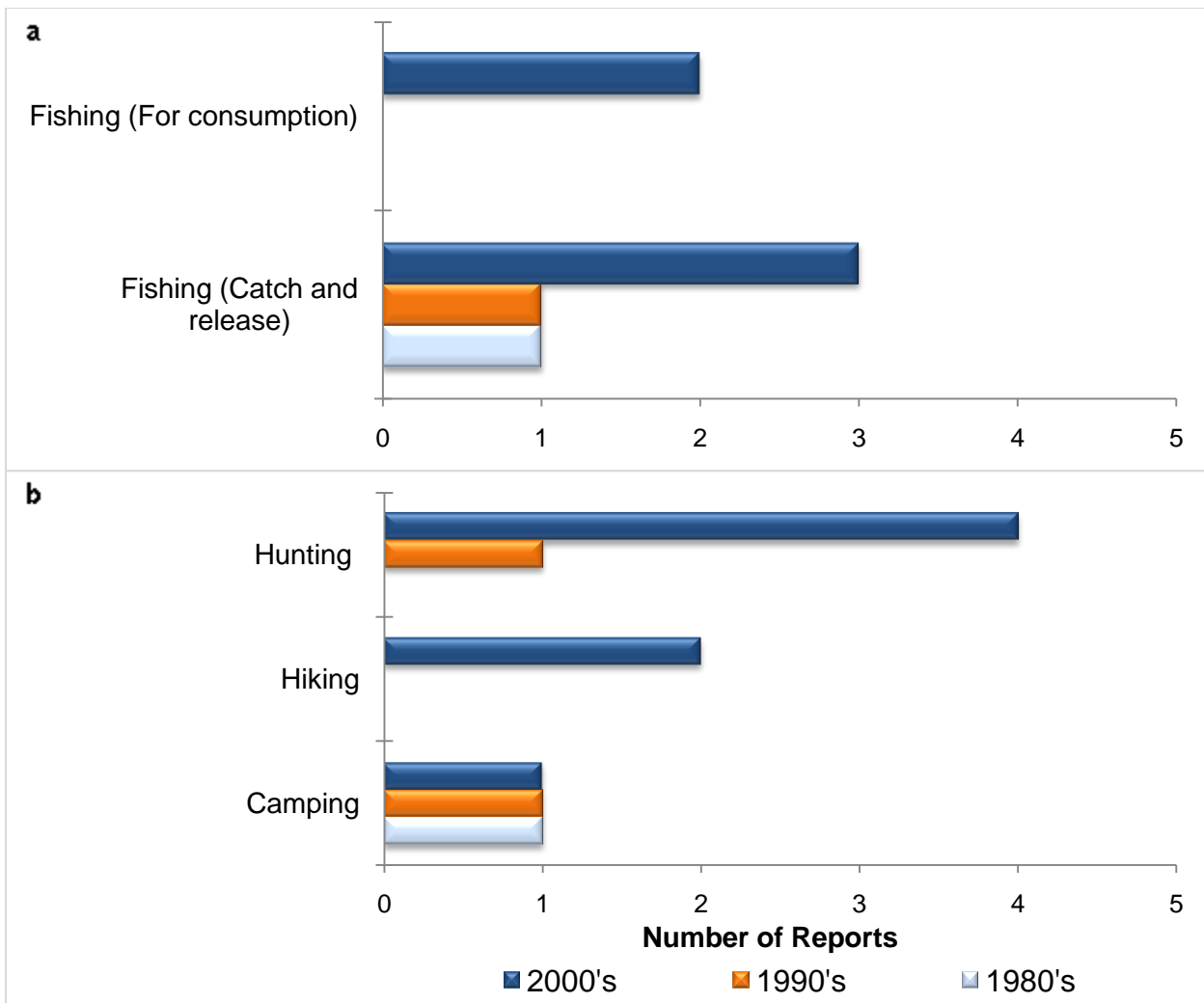


Figure 63. Recreational activities in East Yegua Creek (Segment 1212B) per decade. **a)** Secondary contact activities; **b)** Non-contact activities. The 2000's extend from 2000 to 2010.

Half of the interviewees reported witnessing fishing (catch and release) (reported by 2 people), fishing (for consumption) (reported by 3 people), hunting (reported by 2 people), canoeing (reported by 1 person), and kayaking (reported by 1 person). These witnessed activities involved mainly adults (42%), but teenagers (33%) and children (25%) have also been witnessed recreating in East Yegua Creek. The other half of the interviewees has not witnessed recreation in this stream segment. One of these interviewees, however, has heard of hunting occurring along the creek. The other three interviewees have not heard of recreation occurring in East Yegua Creek.

Five interviewees stated that no changes in recreational activities in East Yegua Creek have occurred over time, while four people stated that changes in recreation have occurred due to decreased water

level. One of these people said that the water is been stored upstream for sale and he also said that there is more bank erosion.

A decrease in the water level appears to have influenced the current absence of primary contact recreational activities involving the interviewees and their families. Canoeing seems to no longer occur in East Yegua and fishing for consumption seems to have decreased as well. Among noncontact recreational activities, hiking has increased and camping and hunting seem to not have changed over time (Table 26).

Table 26. Comparison of recreational activities that characterized East Yegua Creek (Segment 1212B) in the past, versus current personal &/or family recreational activities reported by interviewees

	Past	Present	Change
<b>Primary contact Recreation Activities</b>			
Swimming	1	0	Not reported in present
Tubing	1	0	Not reported in present
<b>Secondary contact Recreation Activities</b>			
Canoeing	1	0	Not reported in present
Fishing (Catch and release)	2	3	increased
Fishing (For consumption)	5	2	decreased
<b>Noncontact Recreation Activities</b>			
Camping	1	1	none
Hiking	0	2	increased
Hunting	4	4	none

Other comments about recreational activities that occurred in the past or that continue occurring in East Yegua creek were: 1) Most recreational activity occurs downstream where the creek widens, however, the person has seen an increase in use since 2006. Upstream has limited access and more private landowners making it difficult for public use. 2) Stream is hard to access due to thick vegetation. 3) Since water level has decreased, the creek has not been used for recreation. 4) Water level used to be high enough to fish on stream. 5) Creek does not contain enough water for recreational purposes.

**Classified Stream Segment 1902 (Lower Cibolo Creek):**

One hundred and twelve mailed letters and 106 phone messages sent or left, respectively, to Lower Cibolo Creek area residents during planned survey work (not including interviews related to Lower Cibolo Creek Public Meeting) resulted in the completion of 34 recreational use interviews. The majority of the people that participated in the interview were landowners (50%) with property adjacent to the river, as well as people recreating on the stream (32 %) (Fig. 64). Eight landowners refused to participate in the interview (Fig. 64).

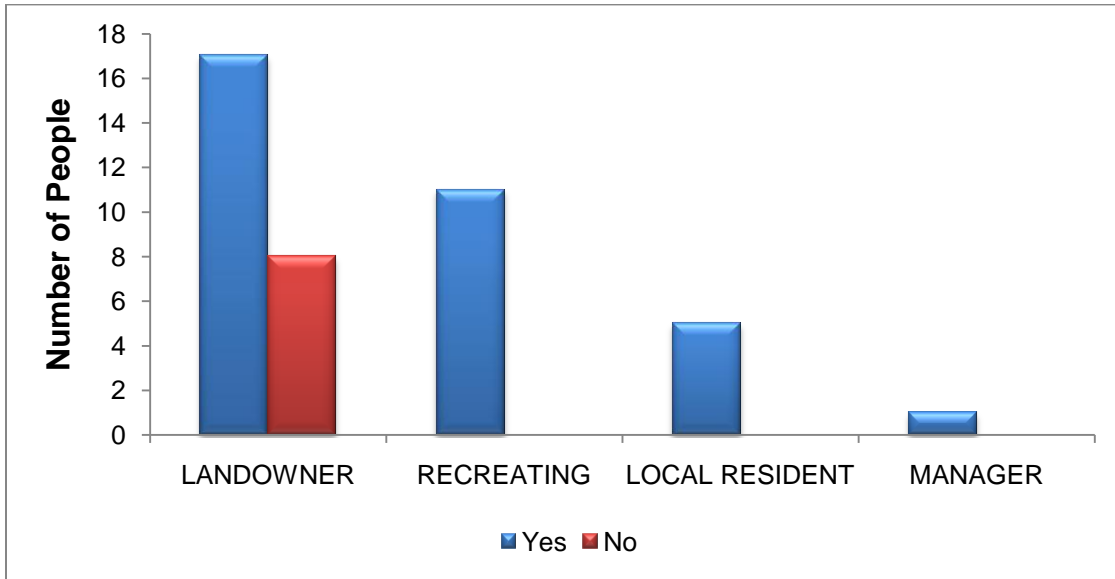


Figure 64. Number of people that participated in interviews assessing recreation in the Lower Cibolo Creek (Stream Segment 1902).

All 34 people that were willing to answer our questions were familiar with the stream. The majority of these people were familiar with the stream for over 20 years (Table 27). Most of the interviewees classified the stream as perennial (91%) or intermittent with perennial pools (9%).

Table 27. Number of years interviewees are familiar with Lower Cibolo Creek (Stream Segment 1902) (n = 24).

No. of Year Familiar	Percentage of Interviewees
>5<10	18%
10 -20	18%
>20<50	35%
≥ 50	29%

The majority of the people that participated in the interviews use the creek for recreation (82%). Fishing (both for catch and release and consumption) was the main activity reported (Table 28). The majority of people reported recreating in Lower Cibolo are adults, although children and teenagers are also frequent users (Fig. 64). Over half of interviewees (57%) stated using the river for recreation between 1 to 30 days per year (average =  $18 \pm 8$  days/year), and 4% of interviewees use the river more than 300 days per year (average =  $288 \pm 83$  days/year). Among the interviewees that use the river for primary and secondary contact recreation activities (i.e. swimming, tubing, wading, boating including canoeing and kayaking, and fishing for both catch and release and consumption; n = 26), 58% reported using the river during 1 to 30 days per year (average =  $17 \pm 7$  days/year), 15% during 31 to 90 days per year (average =  $47 \pm 5$  days/year), 12% during 91 to 181 days per year (average =  $117 \pm 49$  days/year), and 4% during 300 days per year. Half of the interviewees that stated not using the creek for recreation have other personal interests and 33% of the interviewees argued that the water quality is poor for recreation.



Table 28. Recreational activities reported in the Lower Cibolo Creek (Stream Segment 1902) that involve the person that was interviewed and or his/her family. Notice that a single interviewee can report one or more recreational activities.

Personal or Family Uses	Number of Reports
<b>Primary contact Recreation Activities</b>	
Tubing	2
Swimming	5
Wading - Children	3
<b>Secondary Contact Recreation Activities</b>	
Boating	3
Wading-Adults	3
Canoeing	2
Kayaking	1
Fishing (For consumption)	14
Fishing (Catch and release)	10
Playing on Shore	3
<b>Noncontact Recreation Activities</b>	
Camping	6
Hunting	4
Picnicking	1
Watching wildlife or Nature	1

Interviewees had witnessed a large variety of recreation activities in the Lower Cibolo Creek (Table 29). The most frequently witnessed activity was fishing (for both consumption and catch and release). Witnessed recreation activities involved almost equally adults (34% of cases), teenagers (31%), and children (34%); and one person also reported witnessing families recreating in the Lower Cibolo Creek. Only one of the interviewees stated not witnessing recreation, but has heard of camping and fishing occurring in the Lower Cibolo Creek.

Table 29. Recreational activities witnessed in the Lower Cibolo Creek (Stream Segment 1902) by interviewees. Notice that a single interviewee can report one or more witnessed recreational activities.

Witnessed Recreational Activities	Number of Reports
<b>Primary contact Recreation Activities</b>	
Swimming	6
Wading - Children	2
<b>Secondary contact Recreation Activities</b>	
Wading-Adults	2
Boating	9
Canoeing	7
Kayaking	1
Fishing (For consumption)	16
Fishing (Catch and release)	18
Playing on Shore	3
Sunbathing	1
<b>Noncontact Recreation Activities</b>	
Hunting	2
Camping	5
Picnicking	2
Watching wildlife or Nature	2

Interviewees also reported hearing of a large variety of recreation activities occurring in this segment of the creek (Table 30). The most frequent activities that people have heard that occur in the creek were fishing (for both consumption and catch and release) and swimming. 24% of interviewees have not heard of recreation occurring in the Lower Cibolo Creek.

Table 30. Recreational activities that interviewees have heard of occurring in the Lower Cibolo Creek (Stream Segment 1902). Notice that a single interviewee can report hearing of one or more recreational activities.

Recreational Activities Heard of Occurring in the Creek	Number of Reports
<b>Primary contact Recreation Activities</b>	
Swimming	10
Wading - Children	1
<b>Secondary contact Recreation Activities</b>	
Wading - Adults	1
Boating	2
Canoeing	6
Kayaking	1
Fishing (For consumption)	14
Fishing (Catch and release)	12
Playing on Shore	2
<b>Noncontact Recreation Activities</b>	
Hunting	5
Camping	3
Watching wildlife or Nature	1

Reports of personal and family recreational activities by interviewees, in the Lower Cibolo Creek (segment 1902), date back to the 1950's (Fig. 65). Swimming seems to be a recurrent recreational activity since the 1950's. Tubing, and in more recent years wading by both children and adults, have also been recurring recreational activities (Fig. 65a). Fishing, both for consumption and for catch and release, has been occurring since the 1950's and seems to be a prevailing recreational activity in the Lower Cibolo (Fig. 65b). Among noncontact recreational activities, camping and hunting have been occurring since the 1950's; camping in particular appears to be a prevailing recreational activity in the Lower Cibolo Creek (Fig. 65c).

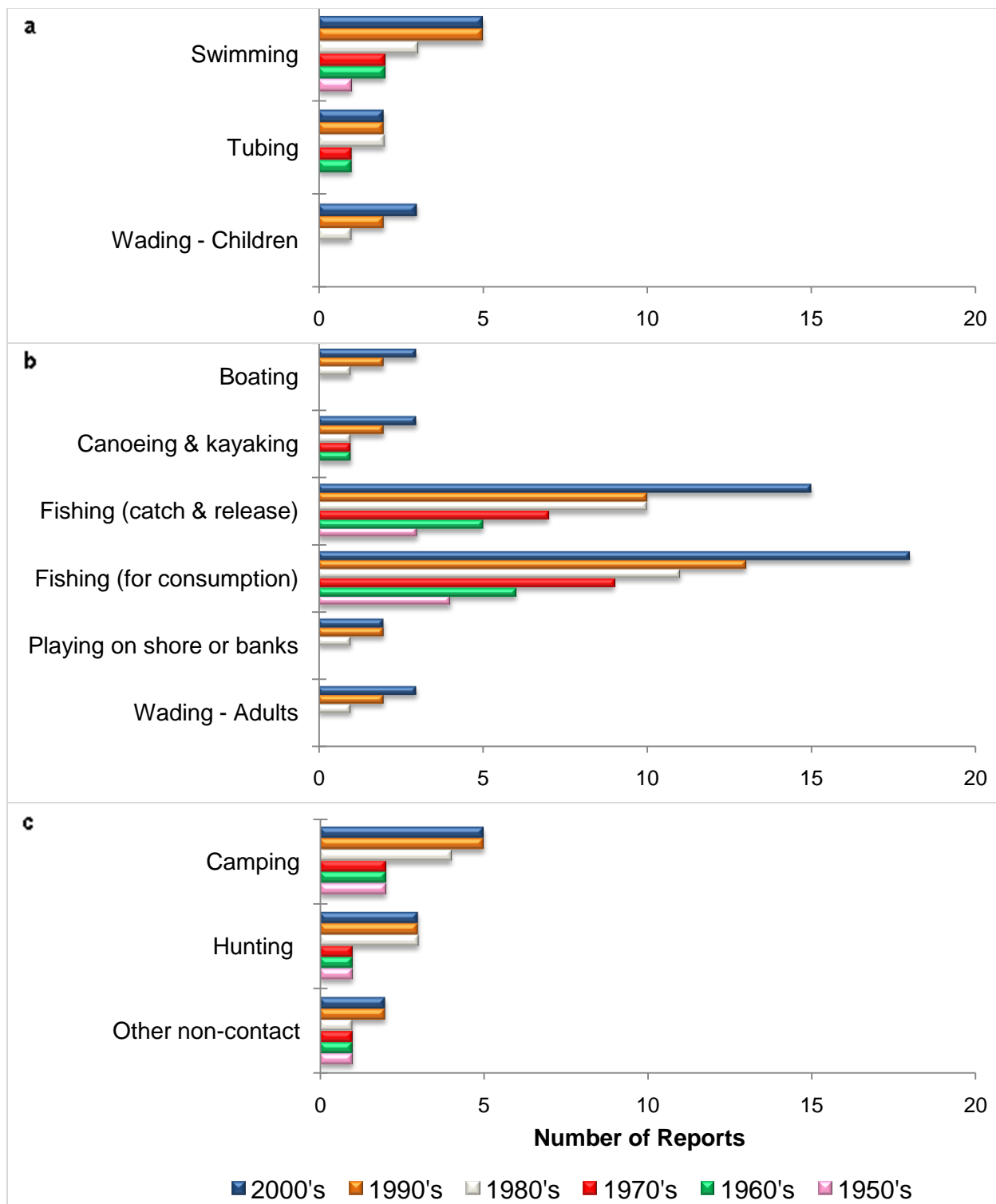


Figure 64. Recreational activities in the Lower Cibolo Creek (Segment 1902) per decade. **a)** Primary contact activities; **b)** Secondary contact activities; **c)** Non-contact activities (other includes picnics and watching wildlife or nature). The 2000's extend from 2000 to 2010.

Thirty-eight percent of the interviewees stated that recreational activities in the Lower Cibolo have not changed over time. In contrast 47% of the interviewees stated that recreational activities have changed, and 44% of them said that such changes are due to lower water quality (all except one person specifically stated that water was polluted or believed to be polluted). Interestingly, all of these people, except for two, use the creek for recreation. Other reasons stated by interviewees for changes in recreational activities were decreased or higher water level (one person each), changes in culture (two people), and increased population size resulting in more recreation (one person).

Changes in water quality and water level may have influenced the current decrease in swimming and increase in wading and tubing. Among secondary contact recreational activities, canoeing, camping and fishing for consumption show a slight decrease over time, while fishing for catch and release and playing on shores seem to have increased. All noncontact recreational activities reported in the creek seem to have increased (Table 31).

Table 31. Comparison of recreational activities that characterized Lower Cibolo Creek (Segment 1902) in the past, versus current personal &/or family recreational activities reported by interviewees

	Past	Present	Change
<b>Primary contact Recreation Activities</b>			
Tubing	0	2	increase
Swimming	9	5	decreased
Wading - Children	1	3	increase
<b>Secondary contact Recreation Activities</b>			
Boating	3	3	none
Wading-Adults	1	3	increase
Canoeing	3	2	decrease
Kayaking	1	0	Not reported in present
Fishing (For consumption)	17	14	decrease
Fishing (Catch and release)	9	10	increase
Playing on Shore/Sun-bathing	1	3	increase
<b>Noncontact Recreation Activities</b>			
Hunting	2	4	increase
Camping	7	6	decrease
Picnicking	0	1	increase
Watching wildlife or Nature	0	1	increase

Other comments about recreational activities that occurred in the past or that continue occurring in Lower Cibolo creek were: 1) Interviewee grew up in the area and learned to swim at bridge where sampling site 1902.12 is located. 2) Family has owned the land since the 1800's and has always used the stream for recreation. 3) Person does not swim in creek because of waste water treatment plant upstream. 4) Person states that water quality has deteriorated over years. 5) Person complains of water quality degradation.

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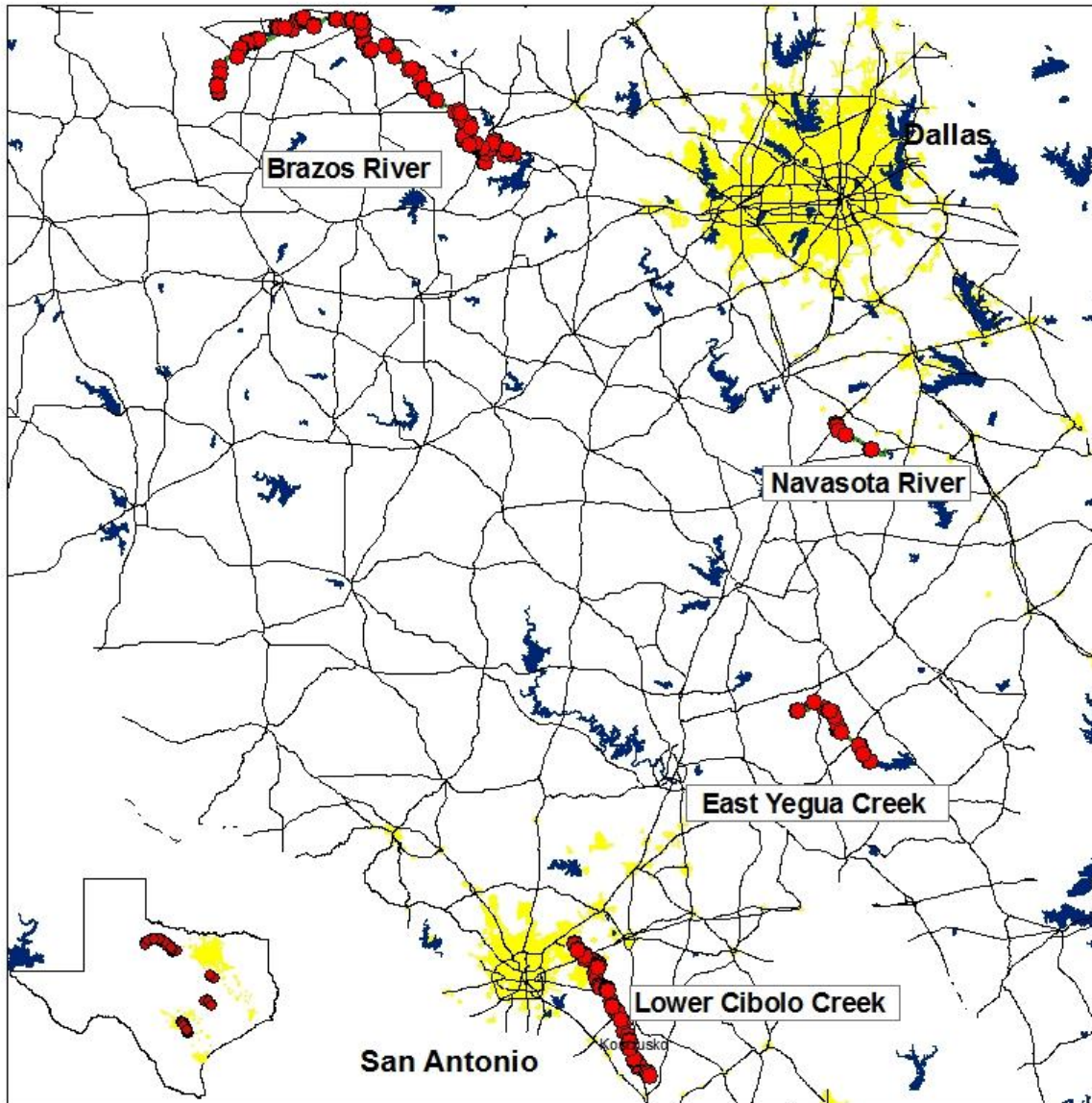
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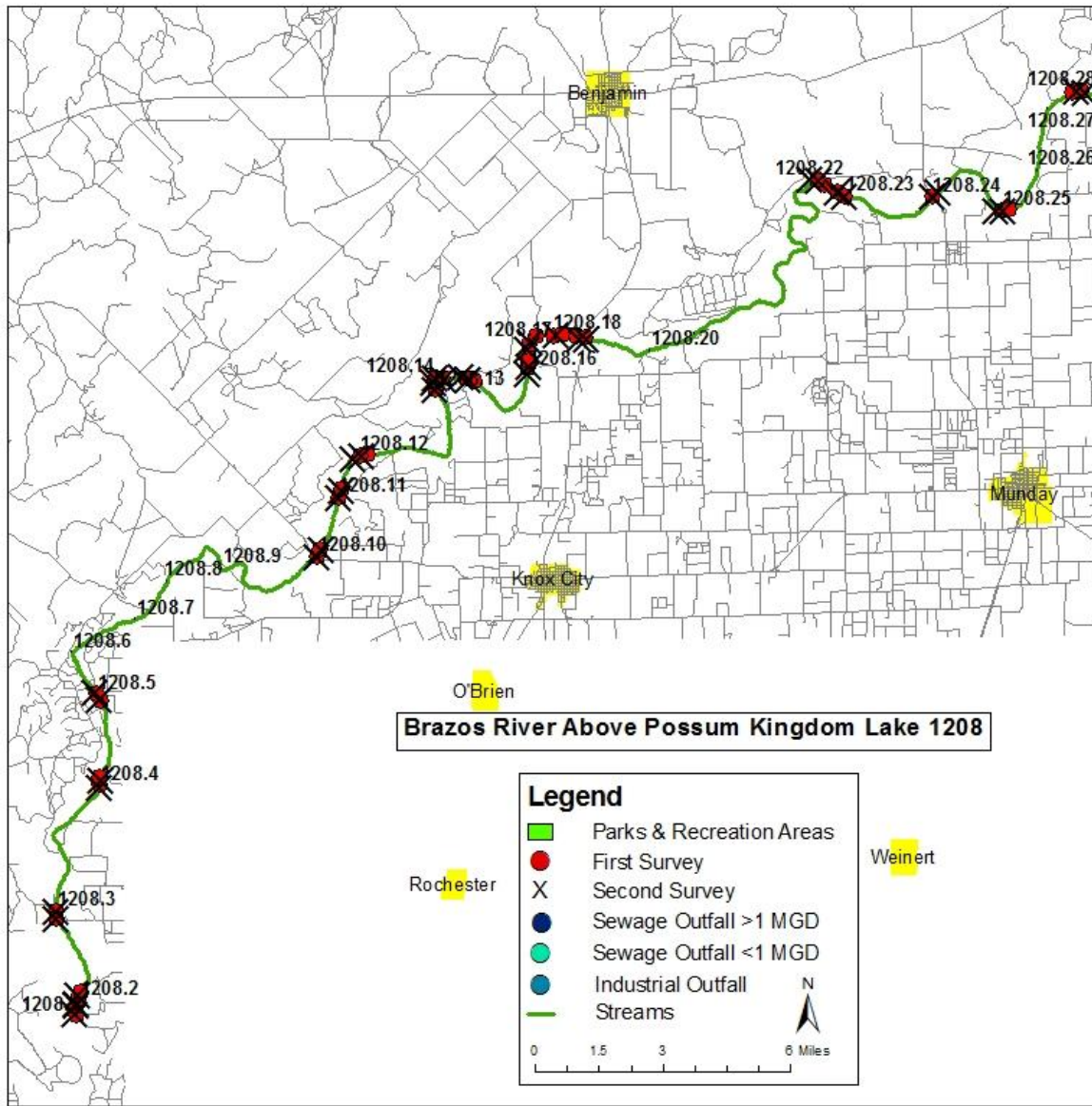
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## Appendices

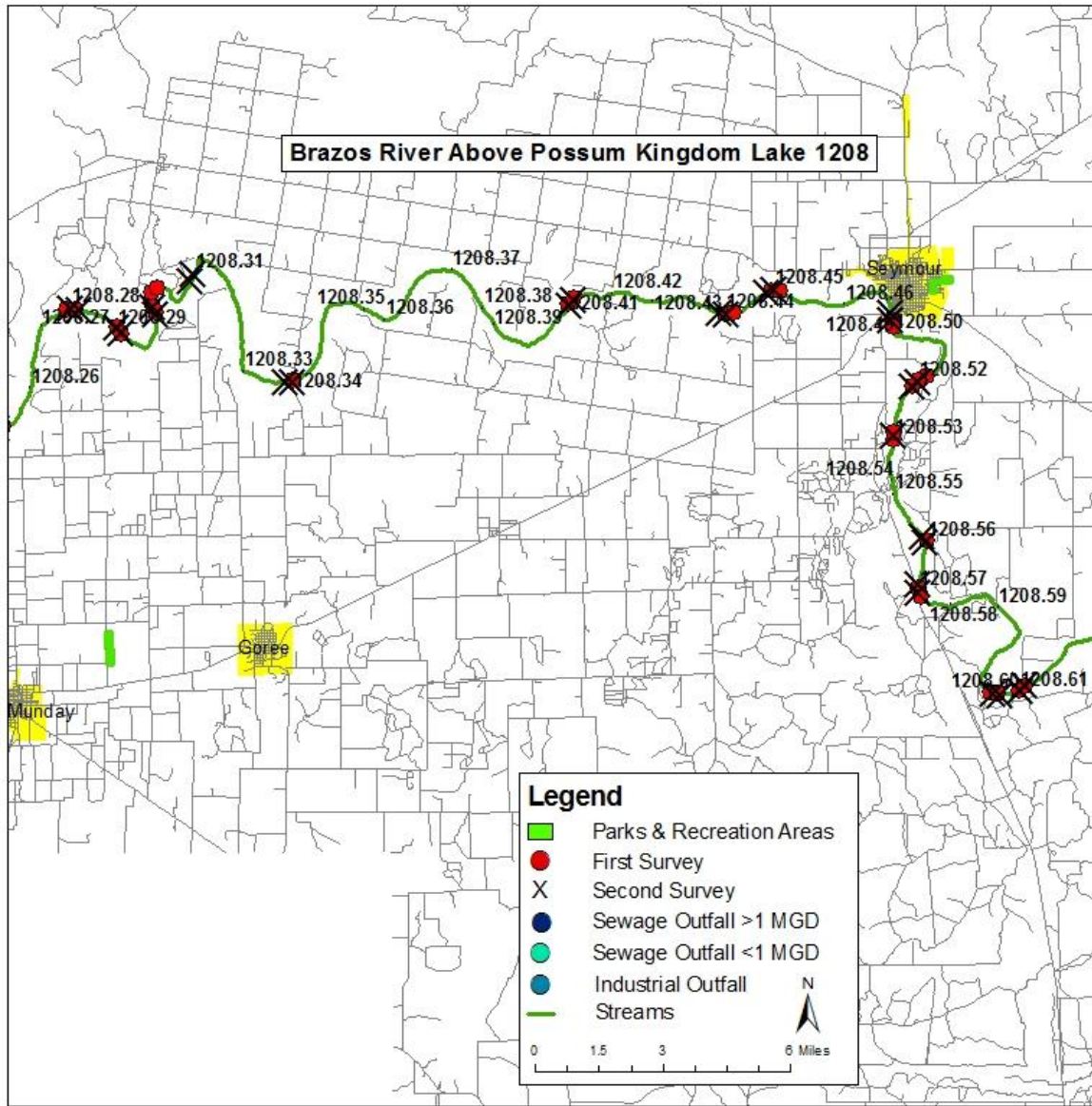
### Appendix 1. Maps of study area and 2010 RUAA streams.



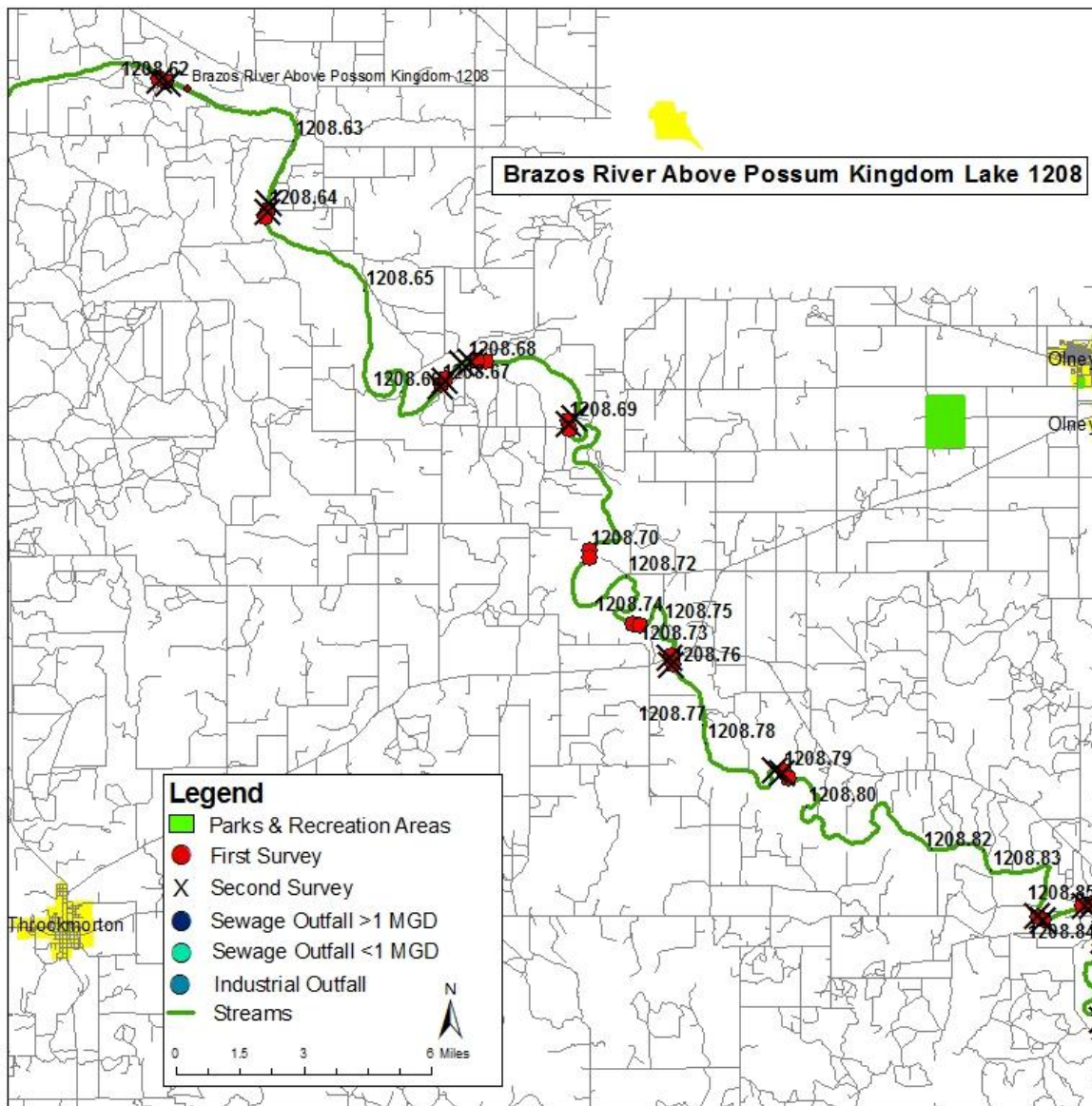
Map of the 2010 RUAA Streams including the Brazos River, Navasota River, East Yegua Creek, and Lower Cibolo Creek.



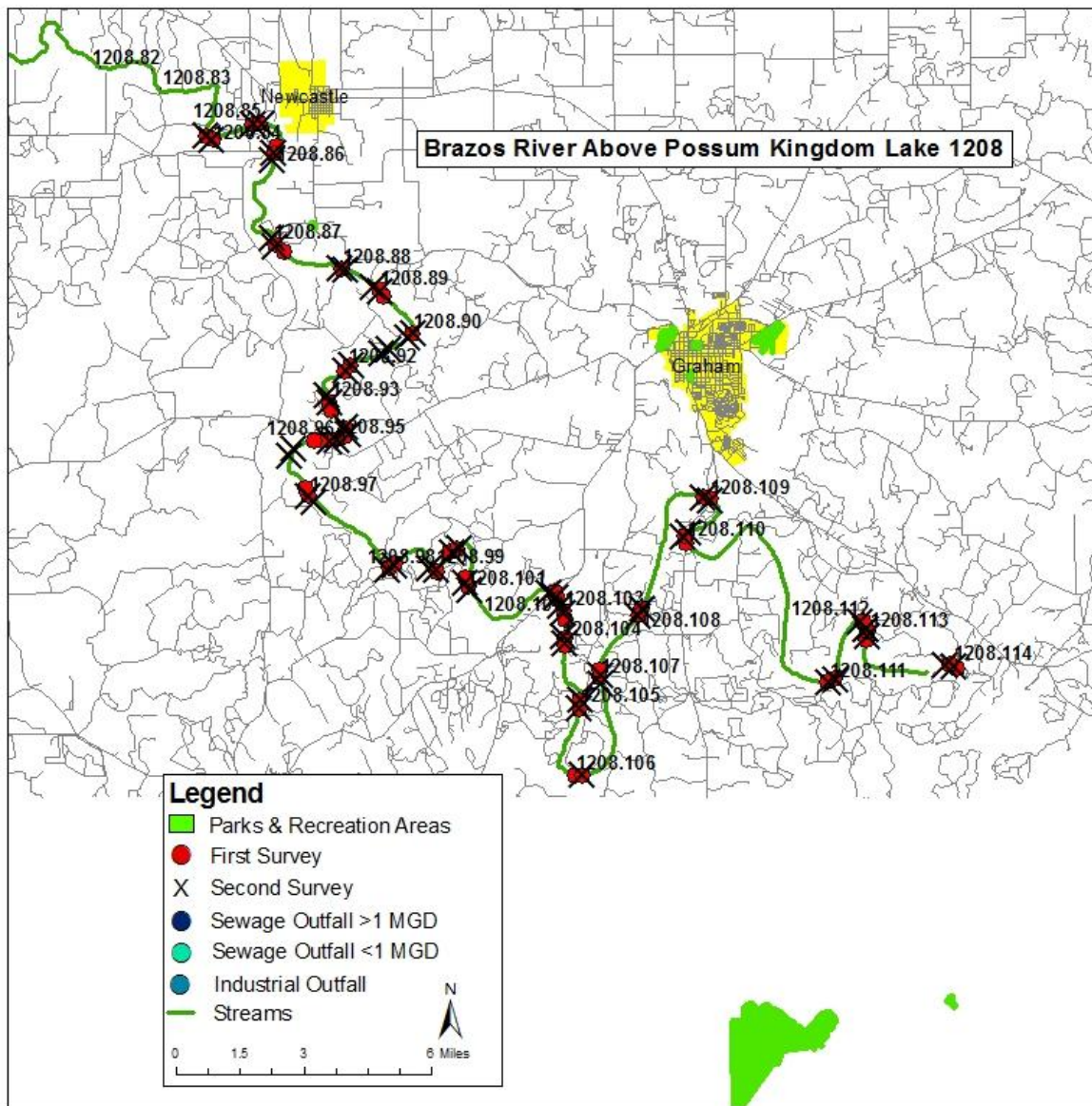
Map of survey sites, recreation areas, and wastewater outfalls along the Brazos River.



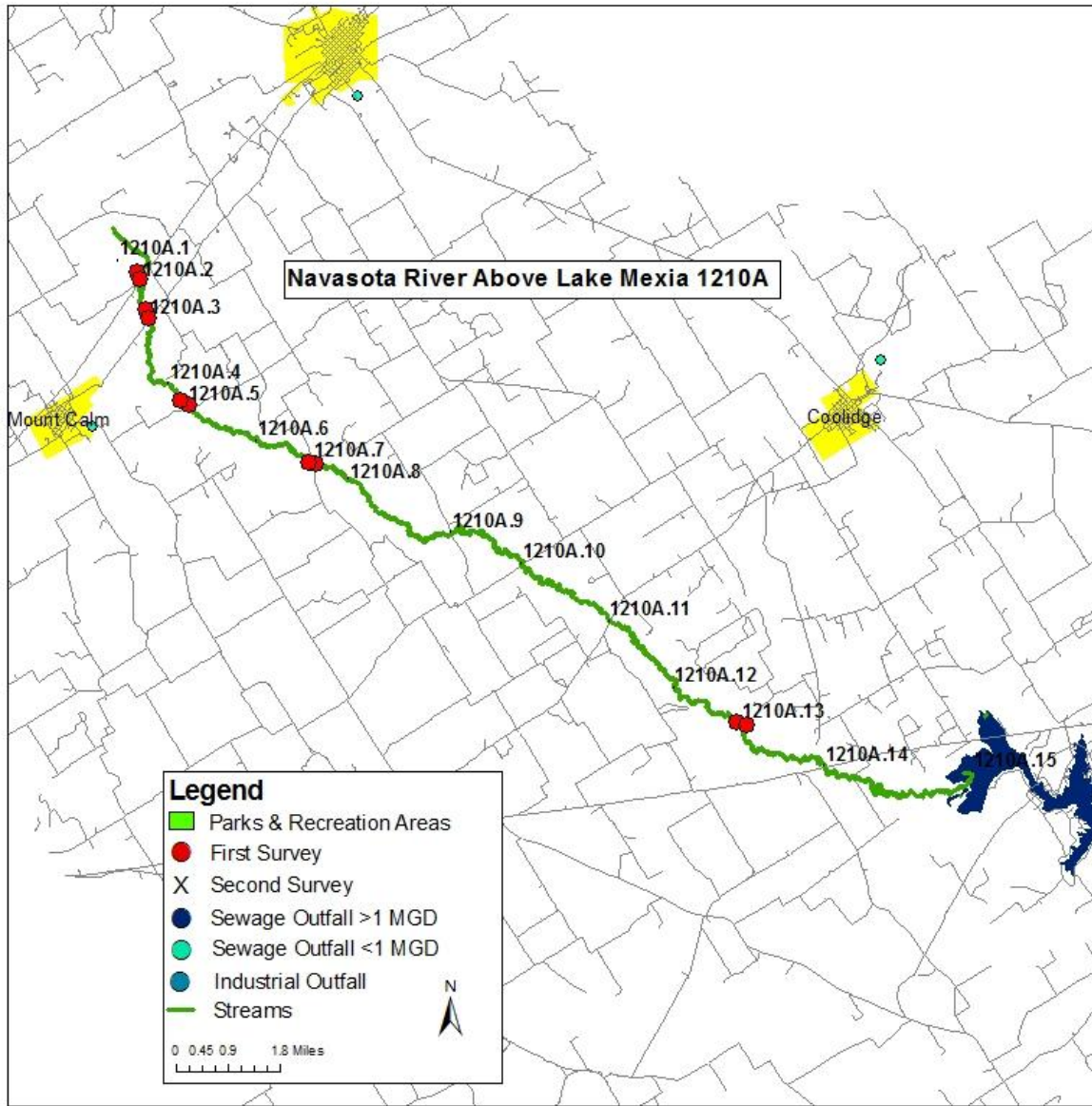
Map of survey sites, recreation areas, and wastewater outfalls along the Brazos River.



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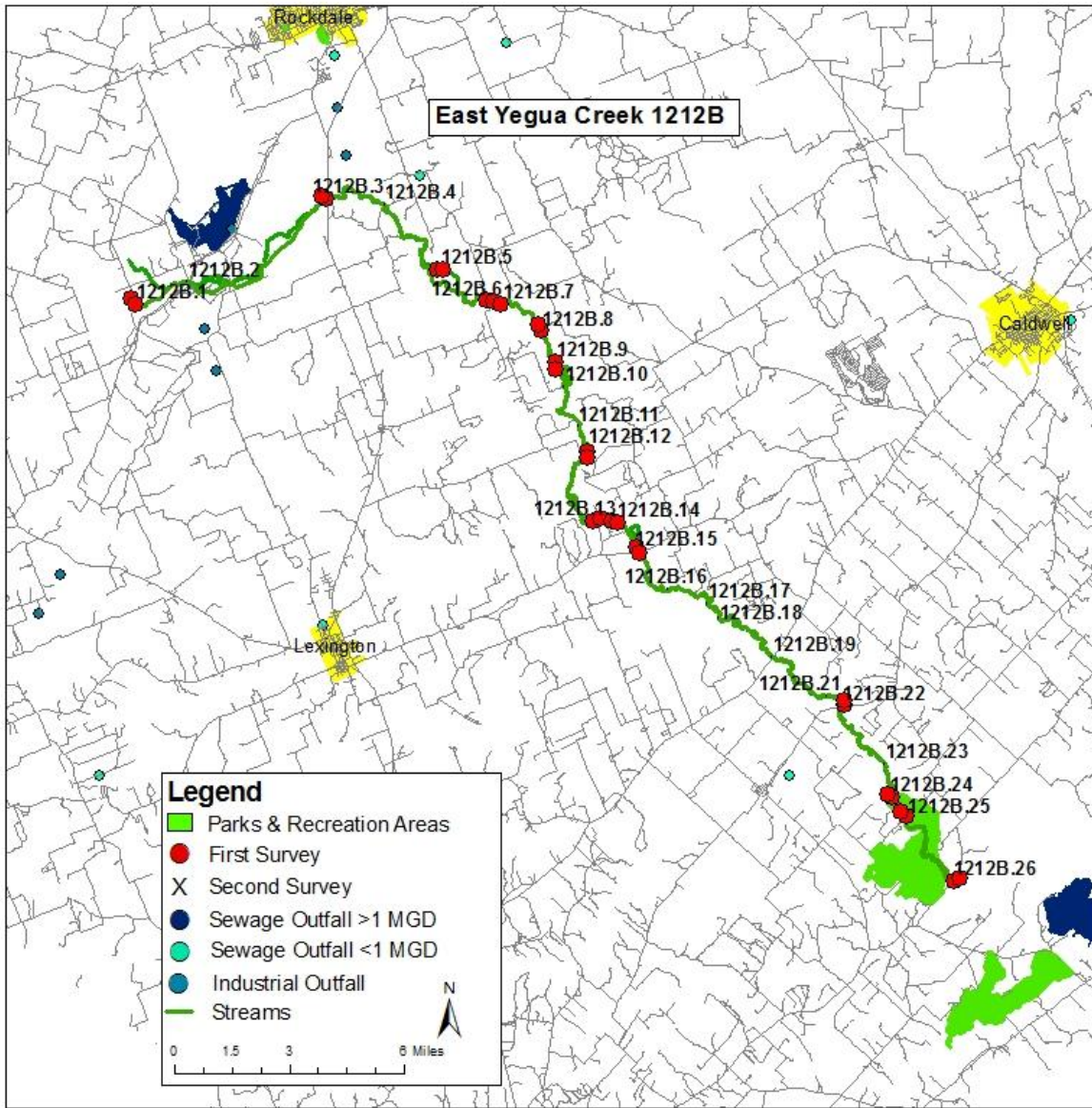


Map of survey sites, recreation areas, and wastewater outfalls along the Brazos River.

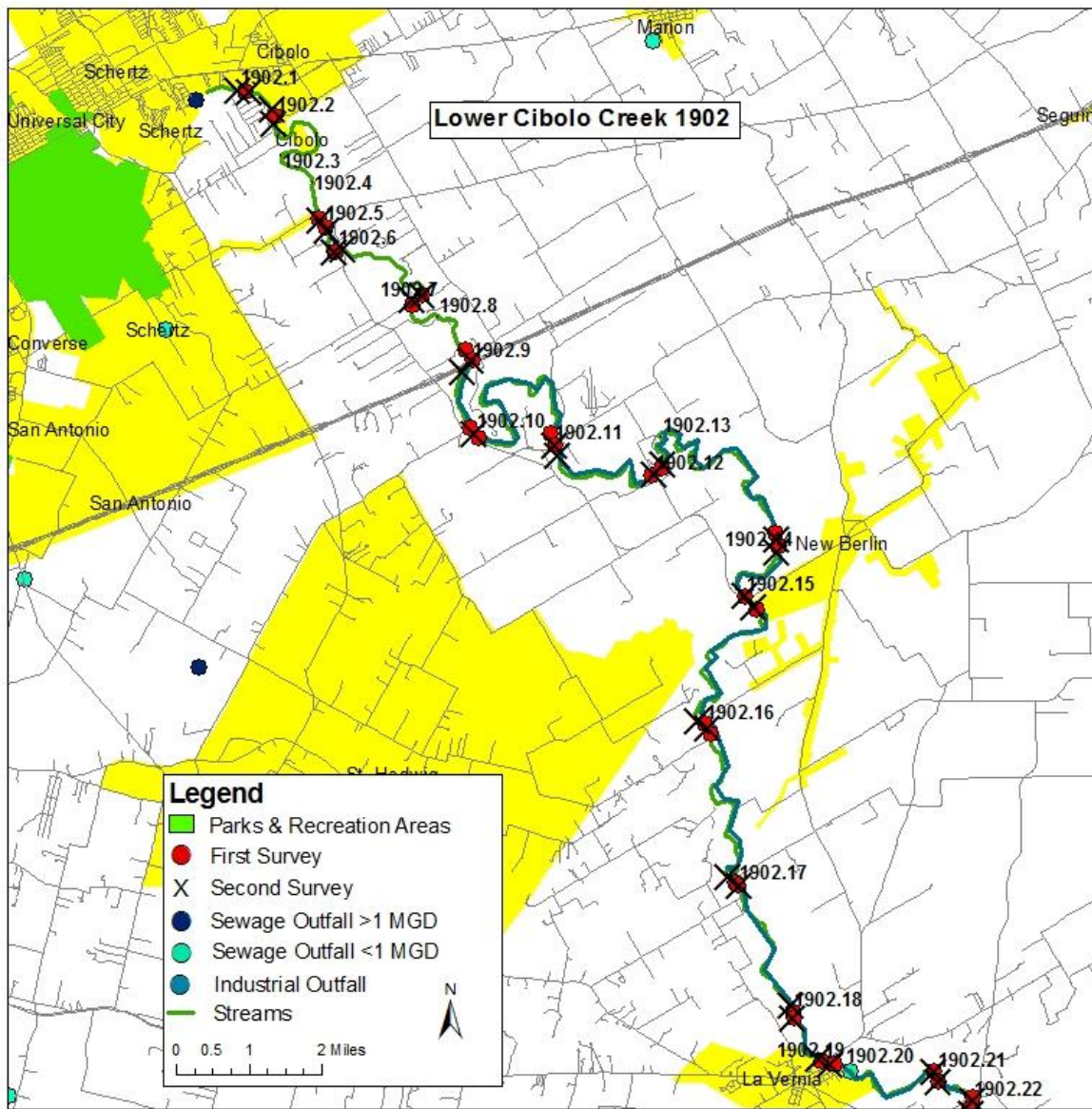


Map of survey sites, recreation areas, and wastewater outfalls along the Navasota River.

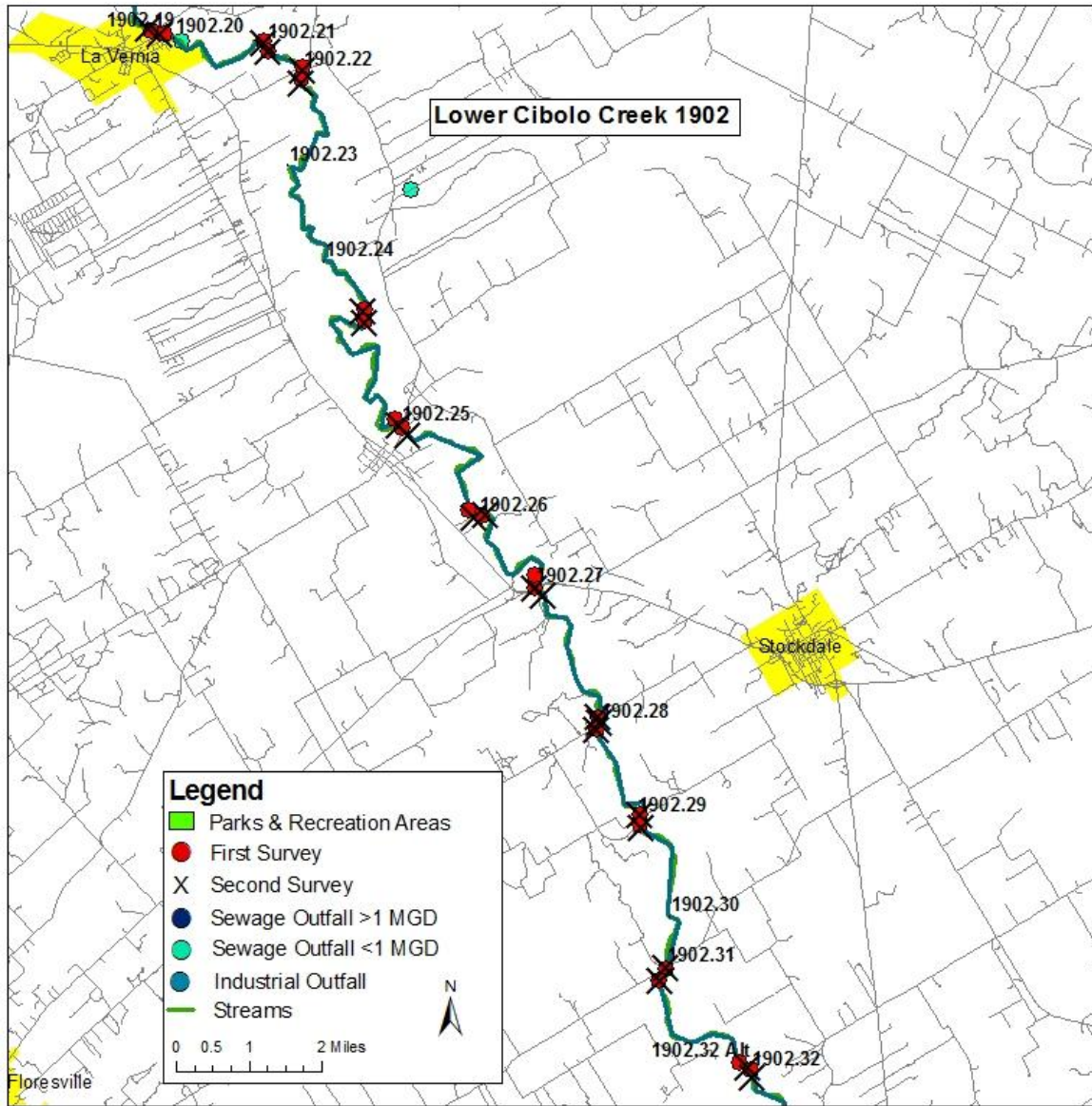




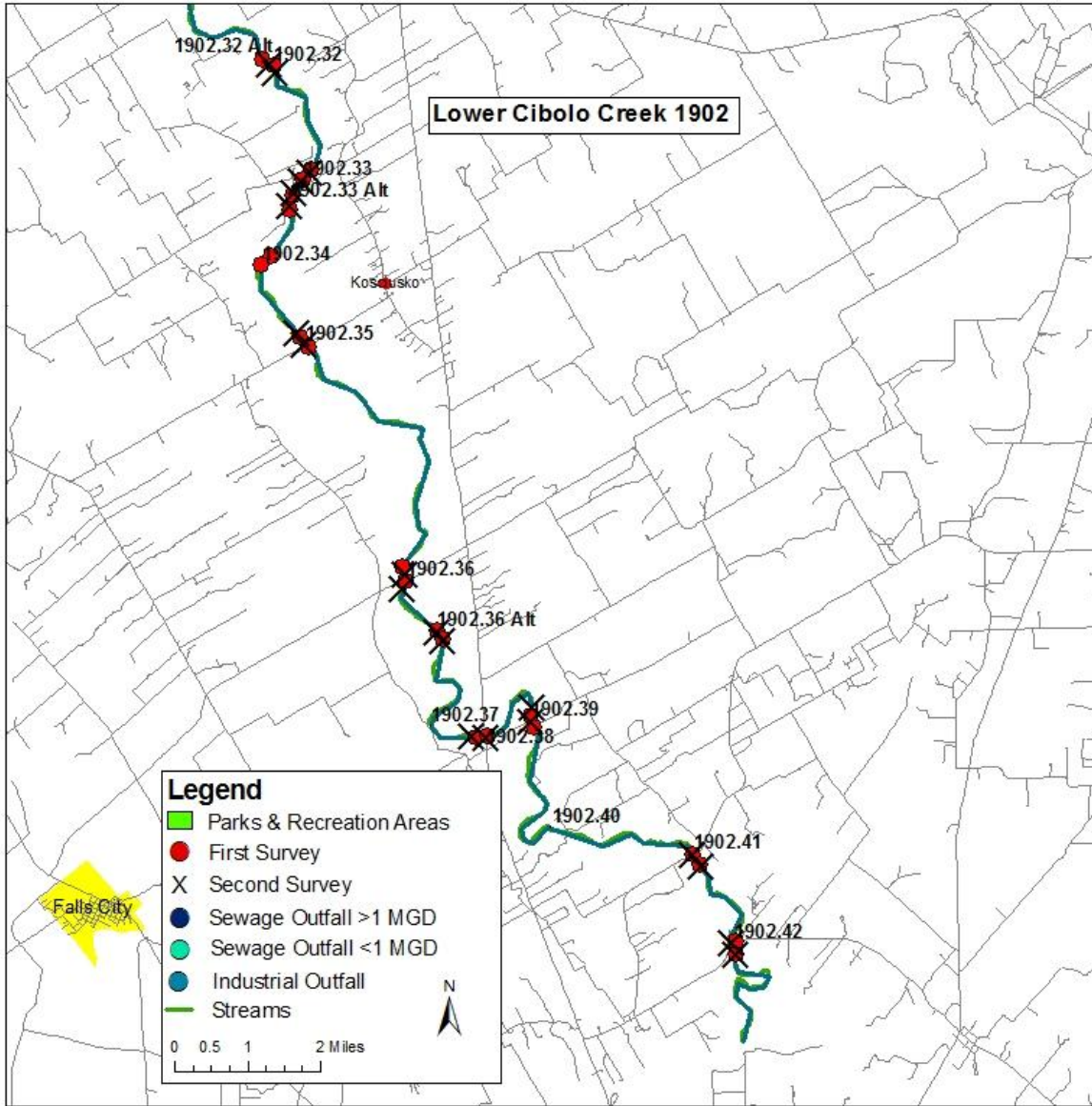
Map of survey sites, recreation areas, and wastewater outfalls along East Yegua Creek.



Map of survey sites, recreation areas, and wastewater outfalls along the Lower Cibolo Creek.



Map of survey sites, recreation areas, and wastewater outfalls along the Lower Cibolo Creek.



Map of survey sites, recreation areas, and wastewater outfalls along the Lower Cibolo Creek.

## Appendix 2

### Contact Information Form

(This form should be completed prior to conducting a Basic RUAA Survey and/or Comprehensive RUAA. *The TCEQ Water Quality Standards Group will not consider or review a RUAA unless the appropriate entities listed below have been notified prior to the beginning of a RUAA. A RUAA should not be conducted until you have received a Notice to Proceed from the TCEQ Water Quality Standards Group.*)

River or stream name: \_\_\_\_\_

*Ask the contacts if a recreational use-attainability analysis is appropriate for the river or stream and check Yes or No below. Document the name of the person contacted and the date they were notified about the proposed RUAA project.*

#### Required Local Contacts:

Clean Rivers Partners (River Authority and other local partners)  Yes  No Date Notified: \_\_\_\_\_  
Name: \_\_\_\_\_

Texas Parks and Wildlife Department region staff  Yes  No Date Notified: \_\_\_\_\_  
Name: \_\_\_\_\_

TCEQ region staff  Yes  No Date Notified: \_\_\_\_\_  
Name: \_\_\_\_\_

TSSWCB  Yes  No Date Notified: \_\_\_\_\_  
Name: \_\_\_\_\_

Suggested Additional Local Contacts (*Ask the contacts if a recreational use-attainability analysis is appropriate for the river or stream and check Yes or No below. If contacted, include information regarding notification date and person contacted on a separate page and attach it to this form*):

Local Parks and Recreation Departments  Yes  No

Local Government/Jurisdiction  Yes  No

Local Recreation Groups  Yes  No

Conservation Groups  Yes  No

Local County Extension Agent  Yes  No

Watershed Groups  Yes  No

Long-term Landowners/Adjacent Landowners  Yes  No

Texas Stream Team  Yes  No

Canoe Clubs  Yes  No

City Commissioners Office  Yes  No

Real estate agents  Yes  No

**Contact Information Form**

- Local non-profits  Yes  No
- City/county offices (Engineer, Health, Law Enforcement)  Yes  No
- Flood control districts  Yes  No
- Councils of Government  Yes  No
- TPWD Game Warden  Yes  No
- Other: \_\_\_\_\_  Yes  No

(should be completed prior to conducting a Basic RUAA Survey and/or Comprehensive RUAA)

Draft Definitions (2010 TSWQS Revision)

- Primary contact recreation: Water recreation activities, such as wading by children, swimming, water skiing, diving, tubing, surfing, and whitewater kayaking, canoeing, and rafting, involving a significant risk of ingestion of water.

- Secondary contact recreation 1: Water recreation activities, such as fishing, commercial and recreational boating, and limited body contact incidental to shoreline activity, not involving a significant risk of water ingestion and that commonly occur.

- Secondary contact recreation 2: Water recreation activities, such as fishing, commercial and recreational boating, and limited body contact incidental to shoreline activity, not involving a significant risk of water ingestion but that occur less frequently than for secondary contact recreation 1 due to (1) physical characteristics of the water body and/or (2) limited public access.

- Noncontact recreation: Activities, such as ship and barge traffic, birding, and using hike and bike trails near a water body, not involving a significant risk of water ingestion, and where primary and secondary contact recreation should not occur because of unsafe conditions.

Information from Local Contacts:

1. If any entity answered no, please have them list the reason(s) why:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

2. Did the local entities confirm that primary contact recreation activities frequently occur?  Yes  No

Please describe how often the activities occur?  Unknown  Never  Daily  Monthly  Yearly

If no, explain: \_\_\_\_\_

3. Did the local entities confirm that secondary contact recreation 1 activities frequently occur?  Yes  No

Please describe how often the activities occur?  Unknown  Never  Daily  Monthly  Yearly

If no, explain: \_\_\_\_\_

4. Did the local entities confirm that secondary contact recreation 2 activities frequently occur?  Yes  No

**Contact Information Form**

Please describe how often the activities occur?  Unknown  Never  Daily  Monthly  Yearly

If no, explain: \_\_\_\_\_

5. Did the local entities confirm that noncontact recreation activities frequently occur?  Yes  No

Please describe how often the activities occur?  Unknown  Never  Daily  Monthly  Yearly

If no, explain: \_\_\_\_\_

6. Do the local entities know if this water body provides substantial flow to a water body with primary contact recreation activities (e.g. swimming in a state/local park) or a bathing beach that is located immediately downstream?  Yes  No  Unknown

If yes, have the local entities provide the name of the water body and a description of the location of the primary contact recreation uses or bathing beach.

\_\_\_\_\_  
\_\_\_\_\_

Notify TCEQ Water Quality Standards Group (required):

*Send an e-mail notification to the TCEQ Water Quality Standards Group at [standards@tceq.state.tx.us](mailto:standards@tceq.state.tx.us).*

Notified:  Yes  No

Date Notified by e-mail: \_\_\_\_\_

Date TCEQ WQS E-mail Response Received: \_\_\_\_\_

WQS Group Contact Person Providing Response: \_\_\_\_\_

Did the WQS Group provide a Notice to Proceed with the RUAA?  Yes  No

## Appendix 3

### Field Data Sheets – Basic RUAA Survey

(should be completed for each site)

Data Collectors & Contact Information:	
Date & Time:	County Name:
Stream Name:	
Segment No. or nearest downstream Segment No.:	
Description of Site:	

*At any point during the Basic RUAA Survey it becomes apparent that primary contact recreation is clearly the use for the water body the investigator should stop conducting the UAA.*

#### A. Stream Characteristics:

1. Check the following channel flow status that applies.

dry    no flow    low    normal    high    flooded

2. Check the following stream type that applies on the day of the survey:

Ephemeral: A stream which flows only during or immediately after a rainfall event, and contains no refuge pools capable of sustaining a viable community of aquatic organisms.

Intermittent: A stream which has a period of zero flow for at least one week during most years. Where flow records are available, a stream with a 7Q2 flow of less than 0.1 cubic feet per second is considered intermittent.

Intermittent w/ perennial pools: An intermittent stream which maintains persistent pools even when flow in the stream is less than 0.1 cubic feet per second.

Perennial: A stream which flows continuously throughout the year. Perennial streams have a 7Q2 equal to or greater than 0.1 cubic feet per second.

Designated or unclassified tidal stream: A stream that is tidally influenced. If you checked this box, you will need to contact the Water Quality Standards Group and evaluate whether or not a bathing beach is located along the tidal stream and whether or not a bathing beach is located along the estuary, bay or Gulf water that the tidal stream flows into.

3. Streamflow

Use USGS gage data (if a gage is located at a site or within a quarter mile of a site) or use the Stream Flow (Discharge) Measurement Form and follow the procedures outlined in the most recent TCEQ Surface Water Quality Monitoring Procedures, Volume 1, RG-415. If USGS gage data is used for a site, include that information as an attachment and list the streamflow on the sampling date below. If the stream flow taken at one site is representative of the flow at another site(s), then that flow can be used as the observed flow and should be documented below. If the stream flow measured at one site is different from another site, then stream flow should be taken at both sites. \_\_\_\_\_ cfs

4. Water Quality Data (Field Parameters)

*Field parameters should be collected in accordance with the procedures outlined in the most recent TCEQ Surface Water Quality Monitoring Procedures, Volume 1.*

Air Temp \_\_\_\_\_ °C

Water Temp \_\_\_\_\_ °C



Stream Name \_\_\_\_\_ Site: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_

5. Riparian Zone (Mark dominant categories) (R (Right Bank). Bank orientation is determined by the investigator facing downstream.)

\_\_\_\_\_ Forest                      \_\_\_\_\_ Urban                      \_\_\_\_\_ Rip rap  
\_\_\_\_\_ Shrub dominated corridor                      \_\_\_\_\_ Pasture                      \_\_\_\_\_ Concrete  
\_\_\_\_\_ Herbaceous marsh                      \_\_\_\_\_ Row crops                      Other (specify): \_\_\_\_\_  
\_\_\_\_\_ Mowed/maintained corridor                      \_\_\_\_\_ Denuded/Eroded bank

6. Ease of bank access to the water body:  Easy  Moderately easy  Moderately difficult  Difficult

7. Please describe access opportunities or explain why the site is not easily accessible (Attach photos for documentation):

\_\_\_\_\_  
\_\_\_\_\_

8. Dominant Primary Substrate

Cobble  Sand  Silt  Mud/Clay  Gravel  Bedrock  Rip rap  Concrete

**B. Primary contact Water Recreation Evaluation:**

- Primary contact recreation draft definition: Water recreation activities, such as wading by children, swimming, water skiing, diving, tubing, surfing, and whitewater kayaking, canoeing, and rafting, involving a significant risk of ingestion of water.

1. Were water recreation activities that involve a significant risk of ingestion (full body immersion) observed at this site?

Yes  No primary contact recreation activities were observed

a. Check the following boxes of primary contact recreation activities observed at the time of the sampling event at the site (Attach photos of the activities or lack of activities).

Wading-Children                       Tubing                       No primary contact activities that  
 Wading-Adults                       Surfing                      commonly occur were observed  
 Swimming                       Whitewater-kayaking, canoeing, rafting  
 Water skiing                       Other: \_\_\_\_\_  
 Diving                       frequent public swimming-created by publicly owned land or commercial operations

b. Check the number of individuals observed at the site:  None  1-10  11-20  20-50  greater than 50

Stream Name \_\_\_\_\_ Site: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_

c. Check the following that apply regarding \_\_\_\_\_ to the water body.

- Water in mouth or nose of the individual     Primary touch: Individual's body (or portion) immersed in water
- Secondary touch: fishing, pets and related contact with water     Individual is in a boat touching water
- Individual is on shore near water within 8 meters (25ft) of water     Individual is well away from water between 8 and 30 meters (100 ft)     Not applicable

2. If primary contact recreation activities are not observed, describe the physical characteristics of the water body that may hinder the frequency of primary contact (depth, etc.) (Attach photos, etc. for documentation).

\_\_\_\_\_

\_\_\_\_\_

3. Describe if there is public access (e.g. parks, roads, etc.) (Attach photos, maps, etc. for documentation).

\_\_\_\_\_

\_\_\_\_\_

4. Is an area with primary contact recreation activities or a bathing beach (e.g. state/local parks with swimming, etc.) located near (e.g. within 5 miles upstream and downstream) this site?

**C. Secondary contact Water Recreation Evaluation:**

- Secondary contact recreation 1: Water recreation activities, such as fishing, commercial and recreational boating, and limited body contact incidental to shoreline activity, not involving a significant risk of water ingestion and that commonly occur.

- Secondary contact recreation 2: Water recreation activities, such as fishing, commercial and recreational boating, and limited body contact incidental to shoreline activity, not involving a significant risk of water ingestion but that occur less frequently than for secondary contact recreation 1 due to (1) physical characteristics of the water body and/or (2) limited public access.

1. Were water recreation activities observed at the site, but the nature of the recreation does not involve a significant risk of ingestion (e.g. secondary contact recreation activities)?  Yes  No secondary contact recreation activities were observed

a. Check the following boxes of secondary contact recreation activities that were observed at the time of the sampling event at the site (Attach photos of activities or lack of activities).

- Fishing
- Boating-commercial, recreational
- Non-whitewater-kayaking, rafting, canoeing
- No secondary contact recreation activities were observed
- Other secondary contact activities: \_\_\_\_\_

Stream Name \_\_\_\_\_ Site: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_

b. Check the number of individuals observe

None  1-10  11-20  20-50  greater than 50

c. Check the following that apply regarding the individuals proximity to the water body.

Secondary touch: fishing, pets and related contact with water  In a boat touching water

Body on shore near water within 8 meters (25ft) of water  Body well away from water between 8 and 30 meters (100 ft)

2. If secondary contact recreation activities are not observed, describe the physical characteristics of the water body that may hinder the frequency of secondary contact (Attach photos, etc. for documentation).

\_\_\_\_\_

\_\_\_\_\_

3. If secondary contact recreation activities are observed, how often do water recreational activities occur that do not involve a significant risk of water ingestion?  frequently  infrequently

Please describe how often the activities occur?  Unknown  Never  Daily  Monthly  Yearly

4. If infrequently, what is the reason?  physical characteristics of the water body  limited public access  other

If other, list reasons: \_\_\_\_\_

5. Describe the physical characteristics of the water body that hinders the frequency of secondary contact recreation (depth, etc.) (Attach photos or depth measurements, etc. for documentation).

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

6. Describe why there is limited public access (e.g. lack of roads, river or stream banks overgrown, etc.) (Attach photos, maps, etc. for documentation).

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

#### **D. Noncontact Recreation Evaluation**

*Noncontact recreation applies to water bodies where recreation activities do not involve a significant risk of water ingestion, and where primary and secondary contact recreation uses do not occur because of unsafe conditions, such as barge traffic.*

1. Provide site-specific information and documentation (including photographs) regarding unsafe conditions, recreation activities, and presence or absence of water recreation activities.

Stream Name \_\_\_\_\_ Site: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_

**E. Stream Channel and Substantial Pool**

Please check the following which best describes the river or stream:  Wadeable  Non-wadeable

1. Wadeable Streams

Determine whether or not the average depth at the thalweg is greater than 0.5 meters and if there are substantial pools with a depth of 1 meter or greater. Walk an approximately 300 meter reach (total) at the site and take the following measurements within the 300 meter reach. Measurements should be taken during base flow conditions (sustained or typical dry, warm-weather flows between rainfall events, excluding unusual antecedent conditions of drought or wet weather

Also, take photos facing upstream, downstream, left bank, and right bank at the 30 meters, 150 meters, and 300 meters.

Photos #s (30 meters) Upstream\_\_\_\_ Downstream\_\_\_\_ Left Bank \_\_\_\_ Right Bank\_\_\_\_

Photos #s (150 meters) Upstream\_\_\_\_ Downstream\_\_\_\_ Left Bank \_\_\_\_ Right Bank\_\_\_\_

Photos #s (300 meters) Upstream\_\_\_\_ Downstream\_\_\_\_ Left Bank \_\_\_\_ Right Bank\_\_\_\_

a) Substantial pools - Measure the length of each pool (if > 10 pools only measure 10 pools), the width (at the widest point), and the deepest depth. A substantial pool is considered a pool greater than 10 meters in length for the purposes of a Basic RUAA Survey. If depth and/or width measurements were not attainable, explain why.

	<b>Length (meters)</b>	<b>Width (meters)</b>	<b>Depth (meters)</b>
Pool 1			
Pool 2			
Pool 3			
Pool 4			
Pool 5			
Pool 6			
Pool 7			
Pool 8			
Pool 9			
Pool 10			

b) Average depth at the thalweg –Take depth measurements approximately every 30 meters to calculate an average depth at the thalweg (at least 10 measurements needed). If depth and/or width measurements were not attainable, explain why.

<b>Distance</b>	<b>Depth (meters)</b>
30 meters	
60 meters	
90 meters	
120 meters	
150 meters	
180 meters	
210 meters	
240 meters	
270 meters	
300 meters	
<b>Average</b>	

Stream Name \_\_\_\_\_ Site: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_

c) Stream width - Measure (1) the width at one point which represents the typical average width of the 300 meter reach; (2) the width at the narrowest point of the stream within the 300 meter reach; and (3) the width at the widest point of the stream within the 300 meter reach.

Measurement Type	Width (meters)
Typical Average Width of 300 meter reach	
Width at narrowest point of the stream within 300 meter reach	
Width at the widest point of the stream within 300 meter reach	

d) Is there sufficient water within a 300 meter stream reach during base flow conditions to support primary contact recreation?  Yes  No

COMMENTS:

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2. Non-wadeable Streams

If accessible, take 10 width measurements which represent typical widths of the 300 meter reach. If the water is too deep and not accessible record the estimated average width of the water body.

Also, take photos facing upstream, downstream, left bank, and right bank at .

Photos #s (30 meters) Upstream\_\_\_\_ Downstream\_\_\_\_ Left Bank \_\_\_\_ Right Bank\_\_\_\_

Photos #s (150 meters) Upstream\_\_\_\_ Downstream\_\_\_\_ Left Bank \_\_\_\_ Right Bank\_\_\_\_

Photos #s (300 meters) Upstream\_\_\_\_ Downstream\_\_\_\_ Left Bank \_\_\_\_ Right Bank\_\_\_\_

# Measurements	Width (meters)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Stream Name \_\_\_\_\_ Site: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_

**F. Additional RUAA Information**

1. Check the following activities observed over the site reach.

- Drinking or water in mouth       Playing on shoreline
- Bathing       Picnicking
- Walking       Motorcycle/ATV
- Jogging/running       Hunting/Trapping
- Bicycling       Wildlife watching
- Standing       None
- Sitting       Other: \_\_\_\_\_
- Lying down/sleeping

2. Are there permanent or long-term hydrologic modifications that are constructed and operated in a way that affects the recreational uses?  Yes  No (If yes, please provide supporting documentation and photos.)

Comments: \_\_\_\_\_

---

3. Check any channel obstructions that apply (Attach photos).

- Culverts       Fences       Log jams       Rip rap       Water control structure
- Barbed wire       Dams       Thick vegetation       Low bridges       None
- Utility pipe       Other (specify): \_\_\_\_\_

4. Check all surrounding conditions that promote recreational activities (Attach photos of evidence or unusual items of interest).

- Campgrounds       Stairs/walkway       Roads (paved/unpaved)
- Other: \_\_\_\_\_
- Playgrounds       Boating access (ramps)       Populated area       None of the Above
- Rural area       Beach       Docks or rafts
- Residential       Bridge crossing       Commercial outfitter
- National forests       Commercial boating       Nearby school
- Urban/suburban location       Trails/paths (hiking/biking)       Power Line Corridor
- Golf Course       Paved parking lot       Parks (national/city/county/state)
- Sports Field       Unimproved parking lot       Public Property

Stream Name \_\_\_\_\_ Site: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_

5. Check all surrounding conditions that impede recreational activities (Attach photos of evidence or unusual items of interest).

- Private Property                       Fence  
 No trespass sign                       Barge/ship traffic  
 Wildlife                       Industrial  
 Steep slopes                       None of the Above  
 No public access                       Other: \_\_\_\_\_  
 No roads

Comments: \_\_\_\_\_  
\_\_\_\_\_

6. Check any indications of human use (Attach photos).

- Roads                       RV/ATV Tracks                       NPDES Discharge                       Organized event  
 Rope swings                       Camping Sites                       Gates on corridor                       No Human Presence  
 Dock/platform                       Fire pit/ring                       Children's toys  
 Foot paths/prints                       Fishing Tackle                       Remnant's of Kid's play  
 Other: \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_

7. Check all water characteristics that apply (Attach photos).

- Aquatic Vegetation:  absent  rare  common  abundant  
Algae Cover:                       absent  rare  common  abundant  
Odor:                       none  rare  common  abundant  
Color:                       clear  green  red  brown  black  
Bottom Deposit:                       sludge  solids  fine sediments  none  other  
Water Surface:                       clear  scum  foam  debris  oil  
Other:  
\_\_\_\_\_  
\_\_\_\_\_

Stream Name \_\_\_\_\_ Site: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_

8. Vertebrates Observed within 300 meter r

Snakes  None  slight presence  moderate presence  large presence

Water Dependent Birds  None  slight presence  moderate presence  large presence

Alligators  None  slight presence  moderate presence  large presence

Comments: \_\_\_\_\_

9. Mammals Observed within 300 meter reach

Wild  None  slight presence  moderate presence  large presence

Domesticated Pets  None  slight presence  moderate presence  large presence

Livestock  None  slight presence  moderate presence  large presence

Feral Hogs  None  slight presence  moderate presence  large presence

Comments: \_\_\_\_\_

10. Evidence of wild animals or evidence of birds, cattle, hogs, etc.

Tracks  Fecal droppings  Bird nests

11. Garbage Observed

Large garbage in the channel  None  Rare  Common  Abundant

Small garbage in the channel  None  Rare  Common  Abundant

Bank Garbage  None  Rare  Common  Abundant

Briefly describe the kinds of garbage observed: \_\_\_\_\_

\_\_\_\_\_

12. Is the site located in a wildlife preserve with large wildlife (i.e. waterfowl) population?  Yes  No

13. Please document any other relevant information regarding recreational activities and the water body in general (for example, area outside of the stream reach evaluated).

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_





## Appendix 4

### Comprehensive RUAA Interview Form

Stream Name: \_\_\_\_\_ Segment #: \_\_\_\_\_ Site: \_\_\_\_\_

Interviewer's Name: \_\_\_\_\_

Date & Time (include AM or PM): \_\_\_\_\_

Interviewed:  In person  By phone  By mail

No interviews were conducted

If no interviews were conducted, please provide an explanation:

\_\_\_\_\_  
\_\_\_\_\_

\*Are you willing to respond to a short survey about this stream?  Yes  No

If yes, complete contact information for the interviewee below. Do not collect name or contact information if interviewee is a minor. The contact information portion is not required if the interviewee does not want to provide this information.

Legal name: \_\_\_\_\_ Daytime phone number: \_\_\_\_\_

Mailing address: \_\_\_\_\_

**Interviewee selected because** (e.g., house adjacent to stream; standing by stream, etc.)

\_\_\_\_\_  
\_\_\_\_\_

#### **Questions:**

1. Are you familiar with this stream?  Yes  No If yes, how many years? \_\_\_\_\_

If yes, proceed to #2. If no, stop here and do not conduct an interview.

2. Describe the location(s) of the stream reach the interviewee is familiar with:

\_\_\_\_\_  
\_\_\_\_\_

Stream Name \_\_\_\_\_ Site: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_

3. Have the interviewer characterize the stream flow. Since the interviewer may not be familiar with TCEQ's definitions or distinction between the different water bodies, please refer to the definitions listed below when asking this question.

Ephemeral: A stream which flows only during or immediately after a rainfall event, and contains no refuge pools capable of sustaining a viable community of aquatic organisms.

Intermittent: A stream which has a period of zero flow for at least one week during most years. Where flow records are available, a stream with a 7Q2 flow of less than 0.1 cubic feet per second is considered intermittent. (Channel contains flowing water for only a portion of the year and surface water may be absent at times.)

Intermittent w/ perennial pools: An intermittent stream which maintains persistent pools even when flow in the stream is less than 0.1 cubic feet per second. (When not flowing, the water may remain in isolated pools.)

Perennial: A stream which flows continuously throughout the year. Perennial streams have 7Q2 equal to or greater than 0.1 cubic feet per second.

4. Have you or your family personally used the stream for recreation?  Yes  No

If yes, proceed to #6. If no, proceed to #5.

5(a). List reasons stream not used. \_\_\_\_\_

5(b). Proceed to #7.

6.) How do you use the stream? When did these uses occur (e.g. year(s); season) and how often (times/year)? What location did these uses occur (get specific location and mark on a map)?

Swimming  Skin Diving  Water Skiing  Wind surfing  Hunting  Wading-Adults

Tubing  Kayaking  Rafting  Trapping  SCUBA diving

Snorkeling  Fishing  Boating  Canoeing  Wading-Children

---

7. Have you observed others using this stream for recreation?  Yes  No

If yes, proceed to #8. If no, proceed to #9.

Stream Name \_\_\_\_\_ Site: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_

8. What kinds of uses have you witnessed? When did you witness these uses occurring (e.g. year(s); season) and how often (times/year)? What location did these uses occur (get specific location and mark on a map)?

- Swimming     Skin Diving     Water Skiing     Wind surfing     Hunting     Wading-Adults  
 Tubing     Kayaking     Rafting     Trapping     SCUBA diving  
 Snorkeling     Fishing     Boating     Canoeing     Wading-Children

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9. Have you heard about anyone using this stream for recreation?  Yes     No

If yes, proceed to #10. If no, conclude the interview.

10. What kind of uses have you heard about? When did you hear that these uses occur (e.g. year(s); season) and how often (times/year)? What location did these uses occur (get specific location and mark on a map)?

- Swimming     Skin Diving     Water Skiing     Wind surfing     Hunting     Wading-Adults  
 Tubing     Kayaking     Rafting     Trapping     SCUBA diving  
 Snorkeling     Fishing     Boating     Canoeing     Wading-Children

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11. Can you recommend someone else we could contact that knows the stream?  Yes     No

If yes, list person's contact information: \_\_\_\_\_

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12. Additional comments (from the interviewee or interviewer):

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## Appendix 5

### RUAA Summary

(Not part of the Field Data Sheet)

*This form should be filled out after RUAA data collection is completed. Use the Contact Information Form, Field Data Sheets from all sites, Historical Information Review, and other relevant information to answer the following questions on the water body.*

Name of water body: \_\_\_\_\_

Segment No. or Nearest Downstream Segment No.: \_\_\_\_\_

Classified?: \_\_\_\_\_

County: \_\_\_\_\_

#### 1. Observations on Use

a. Do primary contact recreation activities occur on the water body?

frequently  seldom  not observed or reported  unknown

b. Do secondary contact recreation 1 activities occur on the water body?

frequently  seldom  not observed or reported  unknown

c. Do secondary contact recreation 2 activities occur on the water body?

frequently  seldom  not observed or reported  unknown

d. Do noncontact recreation activities occur on the water body?

frequently  seldom  not observed or reported  unknown

#### 2. Physical Characteristics of Water Body

a. What is the average thalweg depth? \_\_\_\_\_ meters

b. Are there substantial pools deeper than 1 meter?  yes  no

c. What is the general level of public access?

easy  moderate  very limited

#### 3. Hydrological Conditions (Based on Palmer Drought Severity Index)

Mild-Extreme Drought  Incipient dry spell  Near Normal  Incipient wet spell  Mild-Extreme Wet

## Appendix 6

### List of references consulted during the review on historical accounts of recreation that are not included in the text.

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